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AN EXPEDITION TO THE SOURCE OF THE NIGER.*

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From a boundary commission, equipped with every requisite for making a high-class survey, very important results in the way of elucidating the geography and topography of the country visited are naturally expected. And yet, with regard to the collection of general information on these subjects, a boundary commission has many difficulties to contend with. It is closely tied to one particular line of country, and cannot deviate from it to examine places of special interest which may lie near the route; and the work of delimitation takes up so much of the time available that it is impossible for those engaged in it to give their attention to other matters. Such at least was my experience, and on my return from West Africa, I could not but contrast with regret the smallness of the results we had obtained with the many openings which had been offered to us for adding to our knowledge of the country in every branch of science.

This boundary commission was, it may be hoped, the final step to a series of negotiations which have been going on for many years past. The task assigned to it was to mark out on the ground the boundary, according to the agreement signed at Paris on January 21, 1895, between France and England, which extends from Kiragba on the Atlantic coast to the 10th parallel of north latitude, along this parallel, and up the watershed between the Niger and the waters flowing westwards to the Atlantic, as far as the Niger sources at Tembi Kunda. The chief point of interest in connection with this boundary delimitation was that practically nothing was known about the Niger sources, though they had been visited on one or two occasions, and that their

* Paper read at the Royal Geographical Society, December 7, 1896. Map, p. 348.

position with reference to that part of the Sierra Leone hinterland which had been explored in recent years was quite unknown. The entire region covered by the boundary from Tembi Kunda to the Great Skarcies at Wellia was also unknown to the British authorities, though a part of it had been explored by the French.

On December 16, 1895, the joint commission, consisting on the British side of myself and Lieut. Tyler, R.E., as commissioners, with Captain McKay of the Sierra Leone Frontier Police, Dr. Paris of the Colonial Service, four men of the Royal Engineers, and 448 natives (escort, clerk, interpreters, servants, hammock-boys, and carriers), and on the French side of Captain Passaga and Captain Cayrade, commissioners, with one under officer and 102 natives, and four mules, left Freetown in the colonial steamer, *Countess of Derby*, for Moferri, on the Port Lokko creek, where we transhipped to boats and rowed to Port Lokko. From this place we were to proceed by march to Tembi Kunda *viâ* Bumban and Kruto, and to commence at the Niger sources the frontier delimitation, which was to end at the Great Skarcies, near Wellia. A third French commissioner, Captain Millot, was to meet an officer delegated by the Governor of Sierra Leone at Kiragba, and to delimit the Samu frontier from the Atlantic coast to the little Mola river. This arrangement, however, broke down, and Captain Millot joined the other commissioners at Tembi Kunda, and remained with them till March 9.

Of the French commissioners, the senior, Captain Passaga, is an accomplished topographer, and has served in the topographical department of the French War Office, and on the Algerian 1 : 200,000 survey; Captain Cayrade is an astronomical observer of high qualifications. Both he and Captain Millot have served for some years in the French Sudan, and Captain Millot has been engaged in more than one campaign against the Sofas. The instruments used by the French commission were a large theodolite reading to five seconds, and a powerful telescope for astronomical work, and for surveying a theodolite compass (*boussole Brossé*). The English commission had a 6-inch theodolite reading to ten seconds, a 7-inch and a 5-inch sextant for astronomical work; and for survey work they had, in addition, a large and some pocket prismatic compasses, plane-tables, a perambulator, and a pedometer. They were also supplied with a special camera for taking photographs of the moon and stars for determining longitudes (Captain Hill's method), which was worked by Mr. Tyler, who took the photographs and developed them.

Before leaving Freetown we rated our watches, and read our aneroid at sea-level. I may mention here that the French officers who had served in the Sudan told us, as we marched up country, that we should find the movement of the barometer due to atmospheric disturbances to be very small in the interior. Our subsequent experience

confirmed this statement; even a tornado hardly caused a movement, and when we remained several days in the same place, the barometer readings varied very little beyond the slight daily rise and fall. The heights obtained from barometer readings are, therefore, much more trustworthy than in countries where the barometer has a greater daily variation.

The road from Port Lokko to Bumban being well known, we did not sketch it, but we checked the distances with the perambulator, and observed the latitude every day, using frequently both theodolite and sextant, and taking meridians of the sun and one or more stars. We

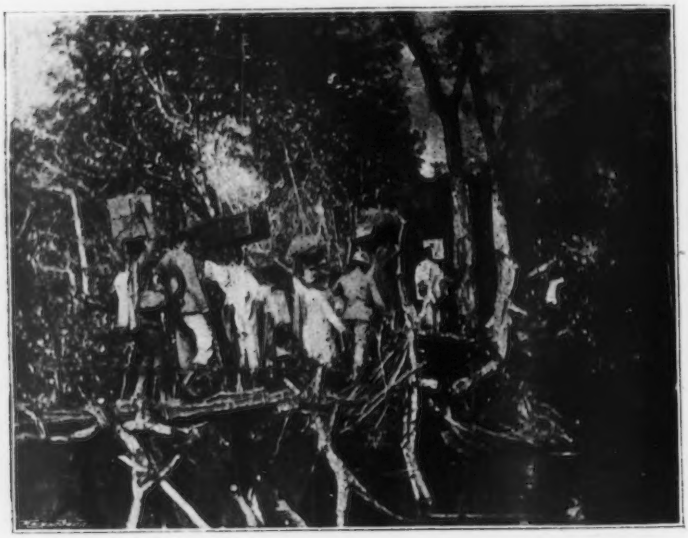
ENTRANCE TO TOWN OF ROTATA.

had some little trouble at first with the perambulator. The native boy who had charge of it could not be persuaded that there was any legitimate method of transport except by resting his burden on his head, and when out of sight he adopted this method. When cured of it, he resorted to the device of reversing the instrument occasionally, reeling off a mile or so, and then making it work backwards for a bit, so as to defy all attempt to get at the distance covered. But we very soon overcame these difficulties, and our operator learned to take a pride in his instrument, and became inflated with conceit at his own intelligence in wheeling it.

The distance from Port Lokko to Bumban by perambulator is 77½ miles, and it took us seven days to cover it. At Rotata we crossed the

Belia, an affluent of the Mabole, which is fordable in the dry season; and near Madina, one march from Bumban, we crossed the Mabole, which is about 90 yards wide, with a swift current and low banks. It is not fordable, and it took us some three hours to get our loads across in the only two dug-out canoes available.

As far as Bumban the country is quite flat, though, after crossing the Mabole, the ground becomes a little more diversified, and large granite boulders are strewn about. The road is a narrow winding track, crossing many streams and swamps, and leading through a region everywhere covered with bush. One has constantly the impression



CROSSING TRESTLE BRIDGE.

that a few hundred yards further on it will be possible to get a view of the surrounding country, but nowhere is it possible to see anything at a greater distance than a hundred yards or so, and the road itself cannot be seen ahead at anything like this distance. Although the trees are not large, nor the bush very dense, one marches altogether in ignorance of what is on either hand, and the villages cannot be seen till they are within a stone's throw.

As one approaches Bumban, hills are visible on the east, north, and south, with curiously shaped summits, some dome-like, some conical, and some columnar, formed of masses of granite. The town, which is the capital of the Biriwa Limba, is large, and lies at the foot of hills which shut it in on the east, north, and south. It has an elevation

above sea-level of 327 feet. The chief is remarkable for the number of wives he possesses—a number which is only exceeded by that of his tame pigeons, which he feeds daily himself. He is held in great dread by his subjects, whom he rules without the assistance of any executive, and even the natives of our establishment had a most extraordinary belief in his power of injuring them as long as they were in Limba country.

Kru, or Kruto, as it is more correctly named, the next point of importance in our route to Tembi Kunda, lies almost due east of Bumban. But the country on the direct line between the two places is quite unexplored, and no roads exist, so we were obliged to follow the Falaba road till we could find a route to lead us eastward. After leaving Bumban, where we had halted for Christmas Day, we commenced almost immediately to ascend the hills, and were soon in an entirely different region, both as regards climate and surroundings, to that of the coast, which may be said to end at Bumban. It is a hilly country of small features and constant ascents and descents. The road is fairly open, but it is difficult even for single men, owing to the steepness of the gradients. It is a strange thing in this country that the roads, which are like a serpent's track on the level, even when there are no obstacles to avoid, generally go straight up and down the steepest hills. Our first halting-place after leaving Bumban brought us to a height of 825 feet above sea-level, and three marches further, at Lengekoro, we had reached an altitude of 1500 feet. At this place we succeeded in finding a man who offered to show us a direct road to Kruto. With this man as our guide we quitted the Limba country, and passed through a hitherto unexplored part of Kuranko country. The first march was difficult, and led through much swamp. It brought us to the new, well-built town of Kundembaia. Here, and at all places till we reached the Bagwe river, the natives were terrified of us. Few of them had seen Europeans before, though some we met remembered the late Captain Lendy, and all of them believed us to be of the nature of Sofas. The chiefs and the menkind generally invariably ran away on our approach, and left the women and the decrepit to receive us; but as soon as they learned that our intentions were not hostile, and that we had trade goods with us, they came out of their hiding-places and were very friendly. The towns in this part of Kuranko country, as throughout the country generally, were entirely destroyed during the Sofa war, and the people are only now coming out of their hiding-places, rebuilding their huts and reoccupying the land.

After leaving Kundembaia we crossed the Seli river, which is about 60 yards wide, with a swift current and stony bottom, by a very ingenious hammock-bridge made entirely of creepers. Three stout creepers act as roadway and handrails, and are fastened to the trunks of trees

on either bank. The roadway creeper is covered with battens of brushwood, and the space between roadway and handrails is enclosed by a network of creepers. The bridge is supported by long creepers fastened to the tops of trees and to the handrails. It bore four carriers with loads at a time.

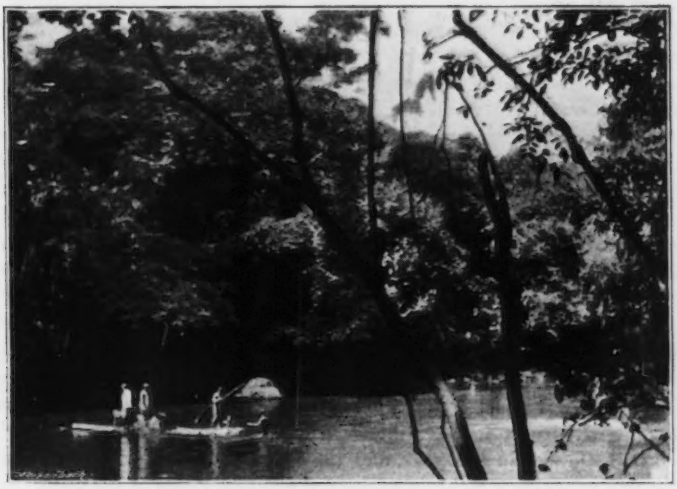
Between Lengekoro and the Bagwe river the dewfall in the early morning was very great. On account of the vapour, it was impossible to see beyond a few yards till the sun was high, and the bush was so saturated that before we had marched five minutes we were as wet as if we had been exposed to heavy rain. Throughout the dry season

HAMMOCK BRIDGE OVER SELI RIVER.

the dewfall was heavy, but it was only in this particular section of the march up that we found it so intense. The country in this region is still hilly. From Lengekoro one descends to the valley of the Seli, and then rises to the watershed between the Seli and Bagwe, Yerembo, the highest point, being 1615 feet above sea-level. From this place the road falls to the Bagwe river. It was in very bad condition when we passed it, and led us through much swamp of a most offensive kind. We found many traces of wild buffalo in this country. The Bagwe, where we crossed it, is about 70 yards wide, and has a rocky bottom and rapid current. It is fordable with difficulty at certain points in the dry season. There is a canoe-crossing opposite Kilela. This town has been recently built by a brother of the chief of Kruto. It is about

a mile east of the Bagwe, and a mile or two west of the Falaba-Kruto road. I should mention here that the Bagwe river is called the Sewa when it reaches Mendi country.

We reached Kruto on January 4, 1896. The distance from Bumban by the route we followed, as measured by perambulator, is 93¼ miles, which it took us ten days to cover, the roads being bad and the country difficult. From Bumban we commenced to sketch the route, using prismatic compass, plane-table, and perambulator, and checking each day's work by latitudes. Kruto is a large town, with police barracks, in a low position, 1160 feet above sea-level. It has recently been moved to its present position from the top of the Kintiballia hill, where the



CROSSING BAGWE RIVER.

chief formerly lived, by order of the governor. The chief is a man of considerable importance. He collected all his people and organized a dance in our honour, which he led himself, brandishing an elephant's tail. We intended to halt here one day, but the effect of our march through the swamps made itself felt, and four out of the seven Europeans were down with fever, so that we had to remain two days in the place. The French officers told us that as long as we kept marching we should be free from fever, but as soon as we halted it would make its appearance; and this was confirmed by our experience. It was during the day's halt at Kruto that the malarial poison made itself felt.

We left Kruto on January 7 for Kurubundo. The country, after crossing the Bagwe river, from being hilly, becomes more distinctly mountainous; the features are larger and bolder, and their direction is

easier to define. East of Kruto the road skirts a high range, which terminates in the Kintiballia hill. On January 9 we reached Kurubundo, 1710 feet above sea-level, situated in a picturesque and interesting position on the upper slope of a steep hill, and surrounded on all sides by impenetrable bush. The town was guarded by a war fence with massive double gates, and the huts were built in the intervals of huge granite boulders. The chief and people appeared to be much more warlike than the Kuranko generally, and they are able to boast that their town was the only one which the Sofas failed to take.

On arrival at Kurubundo, our first business was to find out some route to bring us to Tembi Kunda. No communication existed from the British sphere to the Niger sources, and the distance and direction of the place we sought was a matter of the widest conjecture. We succeeded in getting the chief to interest himself in our journey, and he informed us that there was no road to Tembi Kunda, but he set his people to work the whole night to cut a road through to Porpor, a village which we reached the next day. From thence we marched to Buria, descending to the valley of the Bafin, which we passed east of Buria, and which is here merely a mountain stream. From this point we began a steep ascent, which brought us on January 13 to the western watershed of the Niger, from whence, from an elevation of 3280 feet, we looked down upon the Tembiko valley. We now had reached the eastern limit of the British sphere, and, descending to the Tembiko, we entered French territory. Our guides here considered that their task was ended. They declined to point out the source of the Tembiko to us, assuring us that it was the seat of the devil, whom they had no anxiety to meet, though they are devil-worshippers. They believe that any one who looks on the Niger source incurs the wrath of the devil, and will die within the year, and they regard the water as poisonous. Our own experience rather confirmed the native views of the water, but we were not able to trace any direct connection between its unpleasant effect and the devil. In spite of the failure of the guides, we had not much difficulty in finding the source. On reaching the valley of the stream, we turned along it in a southerly direction, till we had got round the head, and then descended the ravine. The difference between the ground which forms the river valley itself and the country outside the valley, which includes the Niger basin, is very marked here, as always in this West African country. The part outside of the actual valley is covered with cane brake, 10 feet high, yellow, and burnt up. The moment the valley is reached, the bush is green, the foliage abundant, and the trees are covered with creepers and trailers, which make formidable obstacles. The slopes of the Tembiko ravine are steep and slippery, and, as in most valleys of the district, the bush is so dense that sun, air, and light are excluded. It is easy to imagine that the immense quantity of decaying vegetation will not, under these

circumstances, contribute to the healthiness of the country. We descended the side of the ravine, accompanied by Captain Cayrade, cutting our way through bush and creepers, and, reaching the bottom, found a tiny stream issuing from a moss-covered rock. On the rock were cut the initials ("G. B.") of Captain Brouet, a French officer who had visited the place in 1895, and in a small pool was a bottle, with a note giving the date of his placing it there. The spot is certainly a pretty one. Unfortunately, we failed to reproduce it. Mr. Tyler took a photograph, but it failed owing to the want of light. The distance of Tembi

FIRST CAIRN PLACED BY THE TWO COMMISSIONS AT THE NIGER SOURCE.
(From a photograph by Captain Passaga, President of the French Commission.)

Kunda from Kruto, as measured by perambulator, is 65¼ miles, which it took us seven marches to cover.

Our camp was fixed on the ground bordering the ravine, and nearly due west of the source. The French occupied ground a little south of us. We found the height of our camp to be 2800 feet above sea-level; the French, who made measurements independently with their own aneroid, made the ground near their camp about the same level as ours, 2820 feet high. We were disappointed not to find the elevation of the Niger sources to be greater. We had expected, judging from the reports of countries near this region, to find ourselves not less than 5000 or 6000 feet above the sea; but there can be no doubt that our measured altitude was not far from the truth. But, in spite of the elevations not being very great, the country about the Niger sources is

distinctly mountainous. Viewing it from any of the elevations about Tembi Kunda, one sees mountains in every direction. Towards the south, at distances of from 4 to 12 miles, are a number of peaks, one of which is Mount Daro; on the north the high columnar-shaped Kula peak (Mount Kolate) is very conspicuous; whilst in the immediate neighbourhood are Mount Konkonante (literally the four heads), the Sulu mountains, two conical and very conspicuous peaks, and Mount Kenna. The highest elevation we recorded, which was on the watershed near Tembi Kunda, was 3379 feet, and I should judge that none of the summits exceeded 5000 feet above the sea. As regards the distance of the mountains not visited, it is very difficult to speak with certainty, but we fixed one peak on the south by triangulation. Distances in this country are most deceiving. We frequently found mountains which we had imagined to be 40 or 50 miles away, to be a quarter of this distance. The haze in the daytime makes it very difficult to see far, and the mist at sunrise is still worse. We found, on many occasions, that with all our telescopes and field-glasses we could not pick up a flag at a range of 4 or 5 miles, or even less, and trigonometrical points could never be fixed at a greater distance than 7 or 8 miles under the most favourable circumstances.

Some difficulty is occasioned to geographers from the confusion of names in this region. A guide from the eastern side of the Tembiko gives quite a different name to places from that used by the Kuranko, and this has been the cause of several mistakes in cartography.

The mountains of this country are composed of masses of red granite. Occasionally their summits and part of their slopes are uncovered, but generally they are clothed with the high cane brake, which makes them very difficult to ascend, and shuts out the view. To climb these hills, forcing one's way through the cane brake, is very slow and laborious work. The natives make bush fires yearly, but when we arrived they had not begun to burn the bush, and afterwards the fires so interrupted our view that we had to stop them. Occasionally the cane brake is varied by a coarse herbage 3 or 4 feet high, which covers loose rocks, and always indicates broken and bad walking.

The valleys are deeply eroded, and have steep sides. They are covered with dense bush. The rubber-vine is found in many parts, creeping on the large trees.

Tembi Kunda is the birthplace of three great rivers. Within a very few yards of the Niger source, the Mantile, which runs southwards, the course of which has not yet been explored, rises; and about half a mile to the west is the source of the Bagwe, which runs through British territory.

The position of our camp, which was about opposite the Niger source, we found, from four meridian observations of stars, to lie in 9° 5′ 20″ N. lat. The French, by circummeridian observations of a star, fixed their

camp in 9° 4′ 55″ N. lat., their position being about a quarter of a mile south of ours. Their observations for longitude gave as result 10° 47′ 0″ W. Major Grant, who fixed Kruto by lunar distances, and then carried the time to Tembi Kunda and back, found the longitude to be 10° 46′ 32″; whilst our meridian distance from Kruto, assuming Major Grant's position for that place, gave 10° 46′ 40″.

As soon as we arrived at Tembi Kunda, we set about arranging for a trigonometrical survey of the watershed boundary. The country is very unfavourable for this class of work, especially on account of the difficulty of working through the bush, of finding places from which the surrounding country can be seen, and of picking up with the

NEAR THE SOURCE OF THE NIGER.
(From a photograph by Captain Passaga, President of the French Commission.)

theodolite trigonometrical points which have previously been observed from. Fortunately, our engineers were of great assistance to us. One of them was a very good observer, and all were expert chainers, so that, though we had most difficult ground on which to measure a base, the measurements were made with great accuracy. We carried this trigonometrical survey from Tembi Kunda to the 10th parallel, commencing on January 14, and ending on March 4. Several times we broke down owing to the denseness of the bush, and had to measure a fresh base and connect with the work already done. We had much difficulty, too, in judging the direction to be followed, for we had neither the time nor the men available to make a previous reconnaissance of the ground.

The watershed, we found, was continually eluding us, and instead of following the lofty peaks and chains, it more generally passed from one ridge to another by low cols, and it doubled back and twisted in the most unexpected way. We thus sometimes found points which had been observed ahead of us, which we supposed to be on or near the watershed, to lie many miles away from it. Whilst making the triangulation, we at the same time filled in the topography, using plane-tables. Owing to the difficulty of seeing far, we were not able to connect our work with other parts of the interior of Sierra Leone which had been previously explored, except by our route traverse to Tembi Kunda, and by our closing at Kalieri.

Our usual method of procedure was to start as soon as it was light in the morning, after some refreshment, with the intention of getting in to breakfast at about 11 a.m., but we found that in practice we rarely returned before midday, and on several occasions did not breakfast till after 4 p.m. We almost always under-estimated the time required to climb the mountains, the cane brake making our rate of progress terribly slow, and when we had a high mountain like the Kula peak to ascend, it took us the best part of the day. But the most serious difficulty we had to contend with was the management of the carriers. Day after after, as we moved camp, and had ourselves to climb to some elevated spot for surveying purposes, we despatched the carriers with their headmen, giving them the most explicit instructions where to halt; but, in spite of every precaution, I do not think it happened on more than one or two occasions, during the time the delimitation lasted, that we found our loads when we reached the place where we intended to camp. Experience on the West Coast has taught me two things—(1) that if, in the course of their movement across country, carriers, without a European at their head, strike a track, no power on earth will prevent them following it, whatever its direction; and (2) that if there is a town anywhere about, the carriers will inevitably settle there. The French, more experienced than ourselves, and with a smaller and more manageable following, made their carriers follow them wherever they went.

On arrival in camp, as soon as we had breakfasted, we worked out the triangles which had been observed, plotted them, and made a copy of the triangulation chart for the French officers, with description of the trigonometrical points. This chart gave the French a groundwork for their topography, which was placed at our disposal; and indirectly it helped us in another way, for Captain Passaga, in checking the triangles on the ground, more than once discovered an error, due to some small oversight, which, if it had not been corrected, would have permanently distorted the survey.

When we got back to camp in good time, we went out again in the afternoon and surveyed till sunset. After dinner we again worked out

the triangles and plotted the results. Each moment we could spare was given up to this work, and it took us all that we could do to get the results out in sufficient time to be available for the next day's work.

Besides the actual survey of the boundary, much time had to be devoted to delimitation. Each road and track was marked with a beacon at the point where it crossed the frontier. The beacons were made of stones piled in the shape of a sugar-loaf, when stones were available; in other cases ant-earth was used. Sixty-six beacons were built along the watershed on the first section of the boundary, the work being done by a number of carriers.

We left Tembi Kunda on January 19, after a stay of five days. We

McKAY'S GRAVE AT BOGORIA (BORIA).

were led to believe that we should find the whole watershed region to be barren and uninhabited, but this was not the case. About Tembi Kunda itself there are few villages, and these are small; but on reaching Bali on the 26th, we found ourselves in a region as well peopled as any we had passed through, with fair-sized towns at Bali, Yenankolia, Sansanbalia, Kulakoia, and Samaindu. From this point onwards to the 10th parallel the country is well peopled, and though we had occasional difficulties, we were able to subsist our little army of followers on the country.

On January 31, our police-officer, Captain McKay, who had suffered much from fever, was attacked with heat apoplexy near the village of Boria, and, in spite of the unremitting attention of Dr. Paris, he never

recovered consciousness, and died within half an hour of the seizure. The town is in French territory, and we buried him on the outskirts, enclosing the grave and improvising a cross, which we placed at the head. The French officers requested the commandant of the circle to see that the chief of the place kept the grave in good order.

We had now passed the high Kolate mountains, and the country very gradually became less mountainous, though still rugged and difficult. Near Boria are many good-sized towns, the principal British places being Dandafarra, Birimba, Mussadugu, Kirimandugu, Konkekoro, and Kiridugu. Kiridugu is a large and important place, the largest we saw in the interior. It is probable that an exploration of the country lying west of the longitude of Kiridugu, as far as the known part of Sierra Leone, would reveal the existence of many other towns which at present are unknown.

We reached Kiridugu on February 8, and, proceeding northwards, could trace a still more marked change in the nature of the country. It is broken, and very densely covered with vegetation, but the hills are isolated and further apart. It was, however, very difficult for triangulating work, and we had much cutting and clearing to do. On February 12 we arrived at Farama, close to Mount Keme, a large isolated hill which runs east and west directly across the frontier. Passing round this hill, we worked northward, till on February 19 we passed through a defile in another range close to Bonbonkoro. From this place the country becomes much less hilly, the watershed following a series of undulations which are covered with very thick vegetation. West of the watershed the country is a little more hilly, but on the east the hills disappear almost entirely as the valley of the Tintarba is reached. Songoia Tintarba, which is 1550 feet above sea-level, lies in a very flat position. We had great trouble here, not only in surveying, but in tracing the watershed. From the height of the cane brake and bush, we could not see the surrounding country, and it was not possible to say whether the ground a few yards away from us was rising or falling. We had to resort to burning the bush, and to feeling our way through it. On February 25 we reached Kambaia, and found ourselves at last out of Kuranko country. The principal towns after Mount Keme are Morifinia, Kenawa, Dakalofe, Salamaia, and Kombili.

The Kuranko country has no paramount chief. It is broken up into districts, of which the principal along the watershed are *Daldu*, the main towns being Samaindu (where the chief lives), Kulakoia, Birimba, Mussadugu, and Dandafarra; *Mangalia*, principal town—Kiridugu (where the chief lives), Konkekoro, Fangaia, Kirimandugu, Kamoror, Sokorola; *Mongo*, principal towns—Kombili (chief's town), Dakolofe, Salamaia, Boala Karafaia, and Kenawa. These towns are all English; some towns belonging to these districts have been cut into French territory, and are now separated from their chiefs.

The Kuranko as a people are not very high in the scale of civilization. They are timid, and the importance they attach to accuracy is limited. There is much to be said in their defence, however. They have had a very hard time, and have suffered greatly from the Sofas and the Konno people on the east. There is hardly one town now standing which has not been recently rebuilt on or near the ruins of one destroyed by the Sofas, and there are still many ruins of large towns which have never been reoccupied. The entire adult population now existing only escaped extermination by hiding in the bush, and many of them bear traces of the wounds they received in the war-time. The bones of those killed are still visible in places. Considering what they have undergone, one can hardly be surprised that they regard strangers with a certain amount of reserve, and that they cannot credit them with any motive except to kill and plunder. But when once convinced that their throats are not to be cut, the Kuranko are very friendly, and the intense delight with which they regarded the cottons, beads, caps, looking-glasses, salt, and tobacco with which we paid for the rice we got from them, shows that there is in this country an opening for traders, when once the inhabitants have learned to produce what the markets require. At present they produce nothing beyond what they actually use themselves, and as traders have been very little into this country, there is no inducement to grow what they cannot consume. They grow rice, cassava, a little guinea corn, cotton, kola nuts, and an inferior species of tobacco. Rice is everywhere the staple food. The cotton is carded, spun, and made into garments, which are generally dyed with indigo. Kola is the only produce with which any trade is done. It is exported to the French Sudan, where there is a great demand for it. The rubber-vine is found in most of the valleys, but the natives do not understand how to treat it, and make no use of it. Tobacco is carried by every native in small boxes; it is pounded up and used as snuff. The trade tobacco is much preferred to the native product, and a few tobacco leaves given as a present were always looked upon as a great treat.

The Kuranko possess a few sheep, but of horses and cattle there are practically none. The Sofas have, no doubt, accounted for all this form of property. The largest towns have perhaps two or three cows, and occasionally one or two animals which they distinguish by the name of horse, though it is difficult to say on what grounds. The chief of Kombili, who is exceptionally wealthy in this line, and advertises his interest in horseflesh by wearing very tight trousers, brought three animals of this description to greet us, and gave a performance in our honour by galloping them round the hut where we were working till they were hardly able to stand, and he seemed so pleased with the effect produced that he continued the performance on foot, and danced to an admiring circle of his wives.

The great majority of the Kuranko are pagans. Occasionally we

passed a Mussulman town, and it is very remarkable here, as in every part of the Sierra Leone interior, how far the Mohammedans are in advance of the pagans in wealth, in comparative civilization, and in intelligence. No doubt the Mohammedans are ignorant and superstitious, but they have a form of education, there is a school in each village, and what trade there is is entirely in their hands.

The Kuranko are very fond of music. The instrument universally used is made of flat pieces of wood of graduated length fastened to gourds. It is played with sticks, and the performer has iron bracelets attached to his wrists, which add to the volume of sound. A skilled performer can produce a very fair amount of noise with these materials,

MAKING NATIVE CLOTH AT BEREA.

and when half a dozen of them accompany the village tenor, all being congregated inside a small shelter or hut, the effect is very striking. The music consists of a sort of chant composed of two or three notes, which is repeated till the performers are satisfied that the audience has had enough.

On February 22 we invalided the senior of the sapper party, and sent him to Freetown.

At Kambaia we passed from Kuranko to Sulima country. The principal towns between Kambaia and the 10th parallel are Kambaia, Berea Timbako, Berea Futambu, Falaba, Heremakono, and Kalieri. Berea Futambu is the principal British town near the frontier; Kalieri

is a fair-sized town with a police barrack, but with a very bad water-supply. There is a great deal of cultivation in these parts, principally of rice. We reached Kalieri on February 27, and spent four days in the place, surveying the roads, erecting beacons, and taking observations. On March 3 we moved on to a camp which we had selected as being as near as we could estimate to the point where the watershed strikes the 10th parallel. We spent several nights observing here, taking meridians and circummeridians of stars and circummeridians of the sun. At first we could not agree with the French commissioners as to the terminal point of this first section of the frontier; but we got them to bring their big theodolite to our camp, and to observe two

VIEW FROM HEREMAKONO.
(From a photograph by Captain Passaga, President of the French Commission.)

stars, both commissioners taking the times with their own watches and working out the results independently. From these results an agreement was quickly arrived at, and we beaconed the place from whence we were to commence the second section, which follows the 10th parallel as far as the Kaba river. Observations for azimuth were made, and on March 12, turning our faces in a due westerly direction, we commenced to delimit the second section of the frontier. The triangulation was discontinued at the 10th parallel, because the theodolite was required for running the line, and because it was necessary to follow the line so closely that work involving a frequent departure from the parallel was impossible. Our azimuth line, checked by occasional observations for latitude, gave us at all times one

co-ordinate, and for our east and west co-ordinate we relied on the distances given by the perambulator, checked by occasional time observations.

The country, which south of Kalieri becomes less and less hilly as one travels north, the watershed passing over slight undulations in a fairly level country, and the only hills visible being one or two ranges of no great elevation with a generally north and south direction, west of Berea Futambu, in the direction of Falaba, changes once more as one approaches the 10th parallel. From the top of the highest ground north of Kalieri, looking anywhere north of a due east and west line as far as the eye can reach, nothing can be seen but rounded and saddle-backed spurs, knolls, and ridges, all of apparently much the same elevation, and none of them exceeding from 500 to 800 feet above the general level of the country. The features are small, and the hills very close to each other, so that in whatever direction one goes in a straight line, one's progress is a constant passing from hill to valley and from valley to hill. This is more markedly the case in travelling along an east and west line, for the water along this region runs generally from north to south, and the hills, following the same direction, are crossed at their narrowest parts. No rock is exposed on the sides of these hills. They are all covered with a friable loam, and clothed with vegetation. This had been burned in the inhabited districts, and we were able from the high ground to obtain a good view of the surrounding country. The sides of the hills are steep, and the valleys are covered with thick bush.

The camp from which we began the delimitation of this section, on the top of a knoll, was 1750 feet above sea-level. Our first day's work brought us near to Simitia, which lies south of the 10th parallel. It is a clean, well-built town. The villages we passed west of Simitia are under either the chief of that place or of Tagania, a town in French territory. Near Simitia the main French road from Konakri on the Atlantic, *viâ* Ula and Tagania, passes to Sandenia, and then to Sankaran, and the country of the upper and middle Niger.

After passing a few miles west of Simitia, the villages under the chief of that place, we came upon a tract of country entirely uninhabited and given up to big game, which extends as far as Yomaia. Throughout this region we daily crossed many elephant and buffalo roads, running north and south along the river-banks, well tracked and very difficult to distinguish from the ordinary country roads. Our guides all deserted us, possibly from conscientious motives, for when with us we found that their knowledge of the country was not of sufficient value to pay for their keep, and I think it very probable that we beaconed more than one elephant road under the impression that we had to do with routes of trade. Game is very plentiful in this country. The number of elephants which pass through must be great,

but they were all north of us when we were in it. They pass into British territory in the wet season, and leave again at the beginning of the dry months. Buffalo were frequently visible, as well as large and small antelope, and bush-hog. If we had been able to give ourselves up to shooting, we should no doubt have had plenty of sport, but our work kept us so closely engaged that we could only fire an occasional shot, when we put up anything on the road. In a country so closely covered as this is with bush, it is necessary to make special arrangements to get at the game. It is certainly a country in which game is not only very abundant, but as yet untouched by sportsmen.

In passing through this district we were dependent for food on what we carried. Our reserve supplies were consumed during several days' halt near Simitia, where we had some difficulty about fixing the latitude of Bibia, a village close to the azimuth line, and the arrangements we had made for drawing supplies to meet us failed, as the native in charge feared to trust himself in an unknown region. We were soon, therefore, reduced to serious straits to find rice to feed the natives, and for some days the carriers had barely a handful of rice each. Fortunately, when at the very worst, we found locust beans, which kept them alive. But although in such serious difficulties for the want of the necessaries of life, the knowing ones were not altogether deprived of luxuries, and they were generally able to add to their menu either snakes, rats, or squirrels. A beautifully marked specimen of the boa constrictor was killed one day, but before we could take any steps to have its skin preserved, we found that it had been eaten, and that not a vestige remained. Wild honey also was fairly plentiful, and the natives ate it freely, although their indulgence generally resulted in toothache and other aches, which necessitated the use of castor oil, to which they have a singular dislike.

During this part of the delimitation we accomplished from 3 to 4 miles daily. This took us from early morning to sunset, allowing for a halt in the middle of the day for breakfast. We had to cut our way through cane brake and bush, and our progress was very slow. The sun was at this time (March) more powerful than it had been, and the climbing was very exhausting. We began to run the line with the theodolite, but found afterwards the French *boussole Brossé*, a theodolite with a large compass and a case which could be turned by a key so as to set off the magnetic variation, more suitable for the purpose. From many observations which we made, using the largest compass we had, we found the variation throughout the boundary region to be from 18° 12′ to 18° 20′ W. The French results were the same as ours.

Of the rivers passed in this section, the Koka is a small stream; the Mongo a water about 30 yards broad, deep but fordable, with rocky bed; the Kaba, as the Little Skarcies is universally called in this

country, a fine river about 100 yards wide in the dry season, fordable in places, with very little current, and running in a rocky bed. In the rains it must be a very large water. Its valley is about a mile broad, and is shut in by very steep banks from 900 to 1000 feet high as measured by aneroid, the height of our camp on the top of the left bank being 1620 feet. We reached the Kaba on March 29, having passed south of Yomaia, a fair-sized town made up of three separate villages, and we spent two days in correcting the latitude and taking observations for longitude and time. We erected twenty-one beacons on this section of the frontier.

Our next task was to find a point on the right bank of the Kaba

COUNTRY NEAR THE FALL OF THE KITA.

(*From a photograph by Captain Passaga, President of the French Commission.*)

river 4 miles south of the 10th parallel. We did this by measuring a base and running two or three triangles down the river, and on April 2 we fixed the place from which the boundary was to be drawn direct to the Kita-Lolo junction. We encamped on the right bank. Hippopotami were fairly plentiful here; we got one, and our carriers made up for their former fasts by finishing the animal, which was an enormous one, in a couple of days.

Our next task was to delimit a straight line from the point we had fixed on the right bank of the Kaba to the junction of the Kita and Lolo rivers, a distance of about 18 miles. We had thought that this could be done by aligning one or two flags with the terminal points,

but when we saw the country we at once recognized the impossibility of proceeding in this way. The ground was so broken and so thickly covered with bush, that it was not possible to get any positions which could be seen from a distance of more than a mile or two. We therefore sent the sapper party to put up a large flag at the Kita-Lolo junction, and Captain Cayrade and Lieut. Tyler followed the azimuth given on the last Intelligence Division map to see where it would strike the Lolo, and to readjust the direction accordingly. They started on April 4, and, finding the country very difficult, reached the Lolo on the 8th, about 1¾ mile south of the Kita. A new azimuth was worked out, and on April 10 Captain Passaga and I followed this direction and delimited the line, reaching the Kita-Lolo junction on the 13th. The country is decidedly difficult. In character it is very similar to that we had just been through between Kalieri and Yomaia, but it is a little more broken, and the red laterite, so common about Freetown, is exposed in many places, and loose pieces are common. As one nears the Kita-Lolo junction the ground falls, till on the river-bank it is not more than 600 feet above the sea-level. A little east of the Lolo we crossed the Numelo, a river about 50 yards broad and rather difficult to ford. The Lolo is about 75 yards broad, with rocky bottom, and fordable at places in the dry season. The Kita is a small stream 25 to 30 feet wide. All these waters run in open valleys, and have low banks.

From this point we marched, on the 15th, up the right bank of the Kita to Lakhata, a small village in a flat country. The road from the Kita-Lolo junction is quite flat, and Lakhata itself is only 675 feet above the sea. The boundary leaves the Kita 1500 metres (1640 yards) above Lakhata, and this distance was chained, and we encamped near the spot fixed on April 16. The character of the country here changes again entirely. On the north is a very hilly country, Wossu being about the highest point, the hills about which are visible from the banks of the Kaba. These hills push out high bold spurs to the southward, which terminate very abruptly and tower over the flat country about Lakhata. Going northward from Lakhata, we found ourselves 600 feet higher in a distance of less than a mile, and the Kita falls at least 600 feet in half a mile, by a series of rapids and cascades.

Our next point was a gap in some hills about 8 miles away, to which the boundary was to be drawn by a straight line from the position last fixed. We had some difficulty over this, as we found that the gap referred to in the Agreement does not exist, and we had to agree on a point to fulfil the conditions of the Treaty. The delimiting of this line led us over some very difficult country, as it crosses directly several spurs of considerable height with rugged, precipitous sides. On the 22nd we found ourselves at Kunsi, on a broad, flat spur 2800 feet above sea-level. On the top of these spurs the country is more open than in any other part we passed through, and there are many thousand acres

of a perfectly flat, hard surface covered with short herbage, and capable of carrying a very large number of cattle. Numerous herds were being grazed here. The water is good, and the air very much fresher than in the low ground below. These hills are composed of a hard, brittle shale. On the 23rd we reached Kankuia, on a similar but lower spur 2400 feet above sea-level, and the next day we descended by a very steep track to the country west of these spurs, and found ourselves 580 feet above the sea. From the point we had selected to act as the gap the boundary runs in a direct line to a point above a bend on the Kora river, till it meets the great French road from Wellia to Ula. We had no

YUMBOYA.

(*From a photograph by Captain Passaga, President of the French Commission.*)

difficulty in fixing the direction of this line, and on the 25th we reached the Great Skarcies, or Kolinte as it is called here, passing through a perfectly flat country. The British towns of Dumbaia and Saionia lie some miles south of the frontier, but the French town of Ula is close to it. It is a large, very well-built town, with customs-post and white official, barracks, and a store. We put up twenty-three beacons in this section.

The Kora is a large river about 65 yards wide, with low banks near its confluence with the Kolinte, which is a fine water 100 yards wide, and deep, unfordable at any season, running in a perfectly flat plain, with low banks. Our camp on the east bank was 380 feet above sea-level. Wellia is a very small village about a mile west of the river.

There is a canoe-crossing at the place where the road reaches the river.

Game is plentiful in this country. Antelope small and large were seen, and a troop of five elephants passed the night of the 26th close to our camp, and were watched by our followers for a long time the next morning. Mr. Tyler set out after breakfast with his camera, hoping to get them to pose for him; but they had no sympathy with the modern craze for photography, and passed on southwards along the river-bank.

Whilst we had been delimiting the latter part of the frontier, Captain Sharpe of the Frontier Police had been nominated by the governor to meet Captain Millot, the third French commissioner, at Kiragba, on the Atlantic coast, and with him to mark out the frontier from that place to the source of the little Mola river. They commenced work on April 3, and it was anticipated that they would have no difficulty in tracing the boundary, which, after the first few miles, follows the watershed between the Mellakori and Great Skarcies rivers. But it was found that to do this accurately was a very arduous task, as the elevations are very slight and the country thickly covered with bush, and the watershed had to be felt for step by step. They completed the work on April 24, having set up eighty-eight beacons, and joined the other commissioners at Wellia on April 28. Several days were spent there in completing the *procès verbal* of the Commission, and on May 1 the Commission parted from their French comrades, and marched *viâ* Saionia, Berekuri, and Kukuna to Kambia, embarking on May 5, and reaching Freetown that night. The country passed through from Wellia is perfectly flat but for one rise of about 100 feet, the ground hard and free from swamp, and the road good. South of Kukuna the country is very populous, and there is much cultivation.

(*To be continued.*)

SUB-OCEANIC CHANGES.*

By JOHN MILNE, F.R.S., F.G.S.

Section III.

Cable Fracture.

Rudyard Kipling, who, with his powers of description and imagination, carries us from the barrack-room to the home of the deep-sea cables, tells us that in the abysmal depths of the ocean—

> "There is no sound, no echo of sound, in the deserts of the deep,
> Or the great grey level plains of ooze where the shell-burred cables creep."

This description of oceanic plains commands all admiration.

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* Paper read at the Royal Geographical Society, June 18, 1897. Continued from p. 146.

The fact that, in the regions here described, cables lie for years and years without disturbance is another testimony to the facts brought together by geologists to show that the flat plains of ocean beds are regions where there is but little change. Directly, however, we

FIG. 3.—OUTSIDE COVER DAMAGED OFF SENEGAL, MAY 7, 1895.

approach sub-oceanic banks or the margins of continental slopes, although the depths may be abysmal, the fact that cables after interruption have to be broken away from beneath materials which hold them fast, indicates that regions of dislocation have been reached, and what is true for these great depths is also true for localities nearer land. Sometimes cables are bent and twisted, sometimes they are crushed. Now and again sections are recovered which, from the growth of shells and coral on all sides, show that they have been suspended. Others show that fracture has apparently been the result of abrasions, whilst the ends of wires, one of which is concave and the other convex, slightly drawn out, indicate that yielding has been the result of tension. Needle-pointed ends suggest electrolitic action;* but, although cable-interruption may occur in these and other ways, the explanations which best accord with the observations made during cable-recovery generally are those which attribute their dislocation to sudden displacement of the bed in which they are laid, or to their burial by the sliding down of materials from some neighbouring slope.

FIG. 4.—BURIED IN MUD, WEST COAST OF AFRICA. ST. LOUIS SIDE BROKEN, MARCH 12, 1895.

FIG. 5.—WEST COAST OF SOUTH AMERICA. 1891.

* This may be due to electrolitic action between the zinc and the iron of the sheathing wires, or to the cable having rested on a mineral deposit.

Sometimes it will be seen that earthquake movement and cable fracture have been simultaneous, whilst many instances will be given where an interruption has occurred at about the same time that an unfelt movement has been recorded on land. These latter records, which in the lists are marked with an asterisk, are unfortunately not numerous, and only refer to days between the following dates.

1. Observations at Potsdam, Wilhelmshaven, Strassburg, Nicolaiew, Teneriffe, and in Japan. These, which include many of the writer's observations, are published in 'Beiträge zur Geophysik,' Band II., by Dr. E. von Rebeur-Paschwitz, March 27 to October 5, 1889; January 4 to April 27, 1891; February 23, 1892, to August 31, 1893.

2. Observations at Charkow by Prof. G. Lewitzky, August 4, 1893, to October 9, 1894.

3. Observations by Prof. G. Vicentini at Padua, February 1 to August 29, 1895.

4. Catalogues of Prof. P. Tacchini, January, 1895, to October 16, 1896.

5. Observations at Shide, Isle of Wight, by John Milne, August 19, 1895, to May, 1897.

A.—Fracture of Cables in Deep Oceans.

(*The Times of Earthquakes are given in G.M.T. astronomical. Noon* = 24 or 0 *hrs.*)

North Atlantic.—Through the kindness of an engineer, whose experience in the laying and repairing of cables has extended over many years, I am enabled to give the dates at which various cables have become ruptured, or been restored to working order. The only case of alteration in depth which he noticed was during the repairs of November, 1884, but this was not great. It seemed as if the picked-up cable had to be pulled from under a bank of earth which had slipped down from the eastern slope of the Newfoundland bank.

The following is a table of North Atlantic cable-interruptions.

North-eastern Slope of Flemish Cap.—(37° W. to 44° W. long.) July, 1894 (about); June, 1888 (about); September, 1889; September, 1881; June 10, 1894 *; July 28, 4.40 a.m., 1885; April 18, 8 p.m., 1885; July 25, 8 a.m., 1887; June, 1895.

Near South-eastern Slope of the Newfoundland Bank.—(46° W. and 50° W. long.) September, 1887 (about); October 3, 9.15 p.m., 1884; October 4, 4.8 a.m., 1884; October 4, 4 and 8 a.m., 1884; September, 1889.

An unfelt earthquake was recorded, June 11, 7^h 22^m, 1894, very strong at Charkow.

A striking feature connected with these Atlantic troubles is that nearly all have occurred in deep water near to the base of the eastern slope of the Flemish Cap, 330 miles from St. John's, Newfoundland, or the south-eastern slope of the Newfoundland bank. Off the Flemish Cap in lat. 49° N. and long. 43° E. there is a slope, in a distance of 60 miles, from a depth of 708 fathoms to 2400 fathoms, or 1 in 35. Another slope, over a distance of 30 miles, is from 275 to 1946 fathoms, or 1 in 17. Off the eastern side of the Newfoundland bank, in a distance

of 25 miles, the depth changes from 27 to 1300 fathoms, indicating a slope of 1 in 19.

These slopes are all well within the limits at which from time to time yielding due to bradyseismical thrust, secular crush, and facial sliding by overloading, should be expected, and the further a cable can be kept away from the scene of such action, if we may judge from experience, the longer will be its life.

In one case only has the cause of failure been attributed to a landslide, which it is just possible was caused by, or accompanied with, seismic phenomena. A very significant fact is the case when three cables running in parallel lines about 10 miles apart, broke at points nearly opposite to each other, on the same straight line. This was on October 4, 1884. At first the accidents were attributed to the grapnel of a cable vessel, but as no grappling was done then, this hypothesis had to be abandoned. Because three cables broke apparently at the same time in the same locality, one inference is, that the cause resulting in rupture was common to all, and this may have been a sudden change in the configuration of the ocean bed. Such a change does not necessitate any alteration in depth, such as could be detected by sounding, but either a landslip along a line of considerable length or simply a line of fracture like that which was suddenly formed along the Neo valley in Japan, in 1891.

When, on the American and English coasts, types of seismometers which will record the unfelt movements of the Earth's crust have been established, it seems likely that the cause of cable interruptions may be better understood. Because the fifteen repairs indicated in the previous table possibly cost half a million sterling, the localization of areas that should be avoided and the attribution of effects to their real cause are evidently *desiderata* of great importance.

St. Louis—Fernando Noronha.—From a paper read at the Institution of Electrical Engineers by Mr. H. Benest, A.M.INST.C.E., "On some repairs to the South American Company's cables off Cape Verde in 1893 and 1895," it seems that the St. Louis—Fernando Noronha cable has been twice broken. The first break occurred on December 26, 1892, about 130 miles from St. Louis du Sénégal, in a depth of 1220 fathoms, at the time of a heavy gale. The tape covering for 140 fathoms was rubbed bare to the sheathing wires, but on one side only. The sheathing wires at the break were drawn out as if they had been broken in a testing-machine. The Fernando side of the break also showed the effects of rubbing, and the character of the fracture was similar to the other end. In picking up these two ends there was at first a strain in one case not exceeding 2·6 tons, and the other of 4 tons, but as the ends were approached this rose to about 6 tons, when the cable evidently cleared itself from some obstruction, and came easily on board.

Although we have here evidence of what may possibly have been a

submarine landslip, I am not aware that at that time any disturbance was noted in Europe.

The second date is March 10, 1895 *. Here again great difficulty was experienced in breaking out the cable from beneath the mud, detritus, or whatever the materials were that had covered it. The position of this break was about 20 miles south-west from that of 1893.

On March 5, at 22 hours G.M.T., a very large unfelt disturbance was recorded in Europe, and one of moderate intensity at several places in Italy on March 10, at 10.4 p.m.

Mr. Benest holds the opinion that these fractures are connected with submarine river outlets and gully formations in the ocean beds. The gradients in the vicinity of the fractures vary from 1 in 34 (1° 30′) to 1 in 7 (8°).

Pernambuco—Cape Verde.—To the north-west of St. Paul's (lat. 2° 41′ 45″ N., and long. 30° 29′ 15″ W.), which is a volcanic centre, two cables broke simultaneously in a depth of 1675 fathoms, indicating that the rupture was due to a widespread cause. This was on September 21, 1893. Here, in the deep ocean, this was the only failure in nineteen years.

Madras—Penang, and Aden—Bombay.—These interruptions are referred to on pp. 275-76.

B.—Interruptions to Cables on or near to Sub-oceanic Continental Slopes.

West Coast of Central and South America.—As illustrative of conditions which may exist round many parts of the west coast of South America, where there have been sudden and gradual upliftings of the land within historical time, a portion of a chart showing contours near to the mouth of the river Esmeralda is reproduced (Fig. 6). The soundings are in fathoms. Those in ordinary figures are from information received prior to June, 1895, whilst those in larger type are from soundings taken in March, 1896. Changes from 13 or 20 fathoms to upwards of 200 fathoms in this short interval of time are certainly remarkable, and as the position of the cable-repairing vessel *Relay*, belonging to the Central and South American Telegraph Company, which made the observations, was ensured by cross-bearings on the land, their general accuracy cannot be doubted.

The figures surrounded by a circle were taken many years ago, and are probably no longer correct. Off the shore, in a distance of 3 miles, there is a depth of 200 fathoms indicating a slope of 1 in 15, whilst at distances of 10 miles from shore, over a length of 1 mile, slopes of 1 in 3 may be found.

We have evidently here many instances of recent change in sub-oceanic form, and at the same time illustrations of conditions where considerable instability might be expected, and cable-interruptions might therefore frequently occur. It will be noted, by reference to the map, that the position of fractures which have taken place are grouped

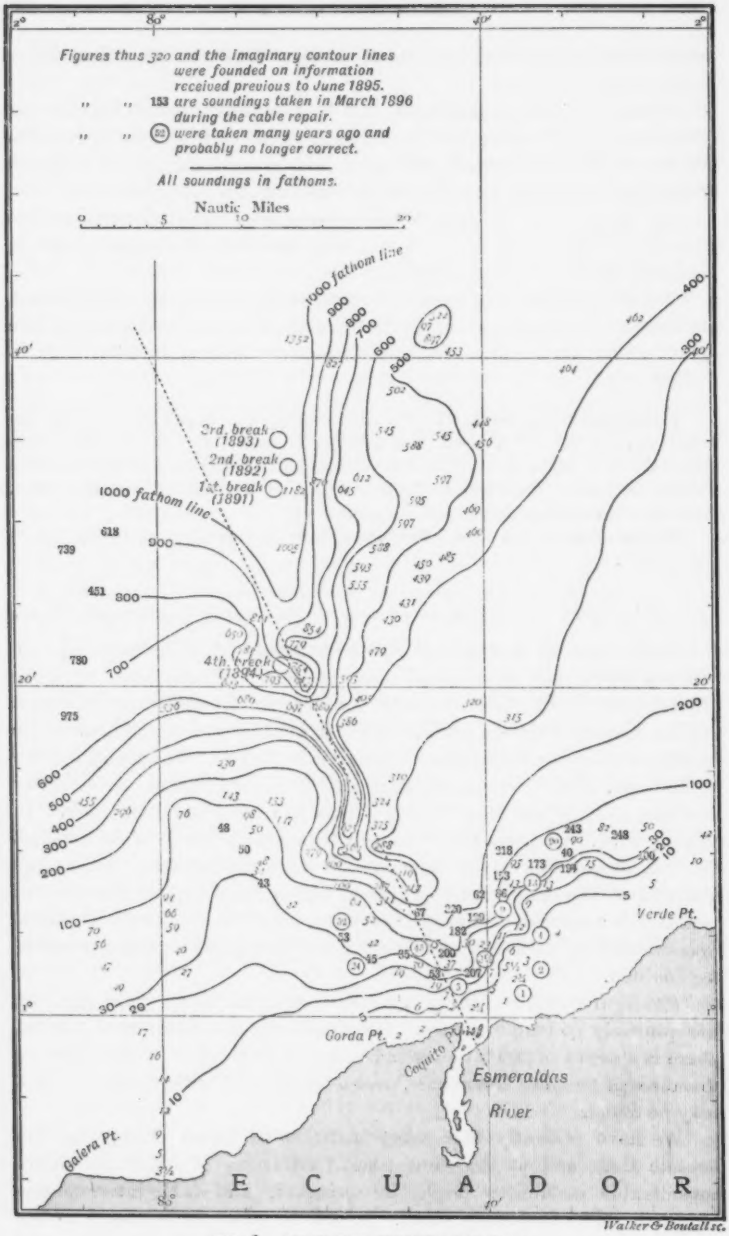

Figures thus 320 and the imaginary contour lines were founded on information received previous to June 1895.
,, ,, 153 are soundings taken in March 1896 during the cable repair.
,, ,, (92) were taken many years ago and probably no longer correct.
All soundings in fathoms.
Nautic Miles
0 5 10 20
1000 fathom line
3rd. break (1893)
2nd. break (1892)
1st. break (1891)
4th. break (1894)
Verde Pt.
Corda Pt.
Coquito Pt.
Esmeraldas River
Galera Pt.
E C U A D O R
Walker & Boutall sc.

FIG. 6.—OCEAN BED OPPOSITE ECUADOR.

near to the base of steep slopes, and in this respect follow the rule of similar occurrences in the North Atlantic.

The following is a list of certain interruptions which have taken place off the coasts under consideration :—

La Libertad—Salina Cruz.—November 25, 1890.

Panama—San Juan del Sur.—June 4, 1889*; July 31, 1889 *.

Sta Elena—Buenaventura.—This section is laid off the mouth of the river Esmeralda, at which point many breaks have occurred (Lat. 0° 58′ 20″ N., long. 79° 41′ 25″ W.). August 30, 1890; January 25, 1891 *; February 13, 1892; December 5, 1893 *; December 6, 1893 *; December 14, 1893 *; December 20, 1893 *.

Paita (Peru)—Sta Elena (Ecuador).—This section passes Talara point, where many breaks have occurred. Lat. 4° 29′ S., long. 81° 17′ W. September, 1892; May 19, 1883; September 3, 1886; May 15, 1889 *; March 31, 1891 *; April 9, 1891 *; May 14, 1892 *.

Mollendo—Chorillos (Peru).—This section crosses the gully off Pescadores point, lat. 16° 24′ S., long. 73° 18′ W. February 23, 1884; March 24, 1884; April 5, 1884; June 13, 1884; January 30, 1886; August 13, 1886; August 16, 1887; March 25, 1887; December 10, 1887, supposed to have been broken by an earthquake; December 11, 1888; February 21, 1890; March 15, 1890; March 30, 1891 *; October 16, 1892 *, supposed to have been broken by an earthquake; June 4, 1895 *.

Arica—Mollendo.—May 9, 1877, by an earthquake; July 15, 1887; before June 24, 1891; August 13, 1891; June 6, 1895 *, shore end broken by waves.

Iquique—Arica.—May 9, 1877, by earthquake; May 7, 1878, by an earthquake; June 12, 1895 *, shore end broken by waves.

Caldera—Antofagasta.—July 7, 1886.

Valparaiso—Serena.—July 26, 1877; August 15, 1880, by earthquake; July 8, 1885; before August 19, 1891; July 4, 1895 *, by landslide or earthquake.

The *unfelt* earthquakes which were noted in or near Europe were as follows :—

January 25, 1891, $5{\cdot}01^{h}$. A small disturbance was recorded at Teneriffe.

March 26, 1891, $13{\cdot}6^{h}$ to $14{\cdot}8^{h}$. There was an earthquake of moderate intensity noted in Teneriffe.

May 15, 1892, $2{\cdot}9^{h}$ at Strassburg, and at $3{\cdot}7^{h}$ Nicolaiew, there was a feeble shock. Origin probably in Norway.

October 13, 1892. At $17{\cdot}07^{h}$, and October 17, at $11{\cdot}88^{h}$ at Strassburg.

December 16, 1893. At Charkow at $13^{h}\ 13^{m}$ there was a strong disturbance.

June 4, 1895. At Padua at $18^{h}\ 23^{m}$, large disturbance.

July 5, 1895, $5^{h}\ 32^{m}$. At Padua, origin evidently at a great distance.

Whether these seven unfelt movements recorded on the eastern side of the Atlantic were connected with seismic disturbances on the western side of South America leading to cable interruptions, it is impossible to speak with confidence until we know the *hours* at which these interruptions took place. In the meanwhile, all that we can say is, that it is worthy of note that out of fifteen cable-interruptions, nine of them took place about the times when delicately suspended instruments in or

near Europe were set in motion. Six interruptions, in some instances cables being broken at more than one point, took place when earthquakes were felt, whilst others were caused by landslips, which in turn may have been the result of mechanical shaking. On certain sections, as, for example, that connecting Arica and Mollendo, fractures have only taken place in certain months, which in this instance are June, July, and August. Restrictions like this suggest that the cause of fracture has been due to landslips brought about by the escape of fresh water beneath sea-level, the action of currents, and other sub-oceanic phenomena having seasonal maxima.

As regards the interruptions off Pescadores point (16° S. lat.), although, when recovering cables, branches of almost petrified trees have been brought to the surface, Mr. R. Kaye Gray attributes them to the great unevenness of the bottom, there being in that neighbourhood submarine hills 3000 and 4000 feet in height.

The following notes bearing upon the above sections were kindly drawn up by Mr. W. E. Parsoné, who has been engaged in cable work on the west coast of South America :—

Arica—Mollendo Section.—This section was laid in 1875. On the night of May 9, 1877, while the cables between Arica and Lima were being used for direct working, a very distinct shock of earthquake was felt by the operator in the Lima office at about 10.30 p.m., during receipt of a message from Arica, and communication ceased a few seconds later. The intermediate station of Mollendo afterwards reported that the shock was also felt there, and at about the same time, and that they were unable to communicate with Arica. Mr. Parsoné located the rupture of the Arica—Mollendo section as close to the shore at Arica, and proceeded by first opportunity to that place, where it was found that a violent earthquake shock on May 9, 1877, had been accompanied by a tidal wave of unusual severity, which had completely wrecked the greater portion of the town. The sea-front and harbour had suffered enormous damage, the iron pier having been washed away, and practically all the craft in the port having parted their moorings or foundered. In undertaking the repair, tons of anchor-moorings and material were picked up with the cable, which had been considerably dragged out of position and twisted for a considerable distance from the shore. Communication on this section was restored on May 24, 1877, and worked without interruption until it was permanently repaired by renewing a portion of the shore-end and intermediate cable on November 17, 1878.

Iquique—Arica Section.—This section was laid in 1875. On May 7, 1878, a severe shock of earthquake was experienced in the neighbourhood of Iquique, after which the cable connecting that place with Arica was found to be interrupted. Mr. Parsoné located the rupture at 6 knots from Iquique on the intermediate cable in 60 fathoms of water, and, after considerable difficulties working with barges, there being no repairing-ship obtainable, succeeded in lifting the cable on the spot. Both ends were recovered, and it was found that the cable (intermediate) had snapped clean through, the compound on either side of the break being undisturbed, except at, say, a distance of 18 inches in either direction, where the sheathing wires had made one complete turn. There the compound had sprung, and some of the strands parted, and the sheathing wires were compressed out of position. But for these comparatively slight indications of the enormous force which must have been exerted to make so

clean a break in heavy intermediate type, the cable was in no way damaged, the rest of the cable being in as good condition as the day it left the factory. The earthquake, which was undoubtedly the direct cause of the rupture, was said to have a direction from south-west to north-east, and it was noticed with much surprise that the base of the high cliffs on the fore-shore bore marks of recent disturbance at a spot bearing due north-east from the position of the break. The disturbance referred to had the appearance of a recently formed cavern or tunnel—a few feet above the beach where the base of the hard rock was met—as if some enormous piece of artillery had been fired point-blank into the rock, and this had also caused a falling away of the surface rock above the opening, which peels off in layers like decomposed slate. We could not land at the place to examine it more closely on account of the surf and rocks, but attempted to do so by clambering and crawling over the headland of rock, but large thin sections of decomposed surface slipped away with us continually, and we had to give up the attempt. Communication was restored with a piece of deep-sea cable and a permanent repair effected by the s.s. *Retriever* on November 21, 1878.

La Serena—Valparaiso Section.—This cable was laid in 1876, and interrupted off the Limaree river on July 26, 1877, as was thought, by floods from the river, although in its normal condition it is practically a dry bed before it reaches the sea.

This section was again interrupted on August 15, 1880, by an earthquake; and the same section was again interrupted by a landslip on July 4, 1885, presumably due to an earthquake.

Mollendo—Chorillos Section.—This cable was laid in 1875, and was frequently interrupted off Pescadores point to the north of Mollendo, where considerable inequality of depth is experienced, due presumably to the channels of an extinct or subterranean river, whose estuary may now be some miles at sea, and create periodical submarine convulsions at great depth and at, say, 40 or 50 knots from the coast. In any case, all difficulty has ceased in this locality, since the cable has, for a considerable length, been diverted to close inland and laid as close to the shore as it was safe for a ship to get.

This section was also broken in two different places by an earthquake which occurred on December 10, 1887.

East Coast of South America.—The geological and topographical conditions on the east coast of South America are strikingly different

FIG. 7.—NORTHERN COAST OF BRAZIL. THIS WAS PICKED UP AFTER BEING LAID ELEVEN YEARS. THE SHEATHING OF WIRE AND HEMP HAD DECAYED, SO THAT THERE REMAINED ONLY THE CORE TO RESIST THE STRAIN.

from those met with on the west coast. On this latter coast the land plunges rapidly downwards beneath the sea, as a slope produced by bradyseismic thrust and folding, whilst on the former, when measured

over long distances, the slope is gentle, indicating an absence of orogenetic activities. Although the land is generally continued seawards at a low

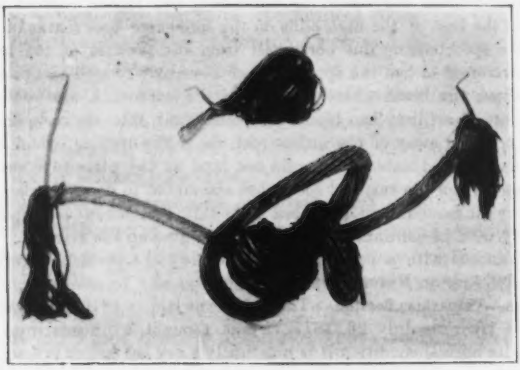


FIG. 8.—PICKED UP IN THE GULF OF MEXICO IN 1888. THE KINKS SHOW HOW MUCH A CABLE WILL STAND AND YET REMAIN IN GOOD ELECTRICAL CONDITION, AS THIS WAS FOUND TO BE.

angle by the deposition of sediments and the scouring action of currents, here and there declivities may have been produced by such epigenic actions.

On the following sections interruptions have been rare or have not occurred:—

Maldonado—Montevideo, since 1875.
Santos—Chuy, since 1892.
Chuy—Maldonado, since 1875.
Rio Grande do Sul—Chuy, since 1875.

From these sections, which lie on the northern side of the Rio de la Plata estuary, as we proceed northwards interruptions have been more and more frequent. They are as follows:—

Montevideo—Buenos Ayres.—October 12, 1889.
Sta Catharina—Rio Grande do Sul.—June 16, 1890.
Santos—Sta Catharina.—March 12, 1890.
Montevideo—Rio Grand do Sul.—April 25, 1889; June 11, 1889*; December 4, 1889; May 4, 1890; December 4, 1891.
Chuy—Montevideo.—June 27, 1892; July 10, 1892* (*restored*); November 11, 1892 (date of *interruption* not recorded).
Rio de Janeiro—Santos.—April 16, 1889; April 5, 1890; December 24, 1890.
Bahia—Rio de Janeiro.—January 31, 1889; September 3, 1889*; September 21, 1889*; July 24, 1891; July 31, 1891; September 4, 1896.*
Pernambuco—Bahia.—April 1, 1889; July 20, 1889; July 14, 1891.
Ceara—Pernambuco.—April 8, 1890; March 14, 1891*; September 1, 1893*; January 12, 1895; March 3, 1896*; March 4, 1897*.
Maranham—Ceara.—May 22, 1889*; April 29, 1890; January 20, 1891;

January 28, 1891; March 4, 1891*; March 8, 1891*; November 25, 1891; October 11, 1892*; February 12, 1894*; March 6, 1894*; November 25, 1894; April 28, 1896*; December 2, 1896*.

Para—Maranham.—September 6, 1888; November 2, 1888; May 22, 1889*; December 27, 1889; January 10, 1890; July 24, 1890; January 12, 1891; October 19, 1891; December 2, 1891; January 19, 1892; October 15, 1892*; March 20, 1893*; September 1, 1893*; March 24, 1894*; July 23, 1894*; November 1, 1894; November 10, 1894; November 13 or 15, 1894; January 7, 1895; February 9, 1895*; October 10, 1895*; December 13, 1895*; December 18, 1895*; July 9, 1896*; August 6, 1896*; October 8, 1896*; May 5, 1897*.

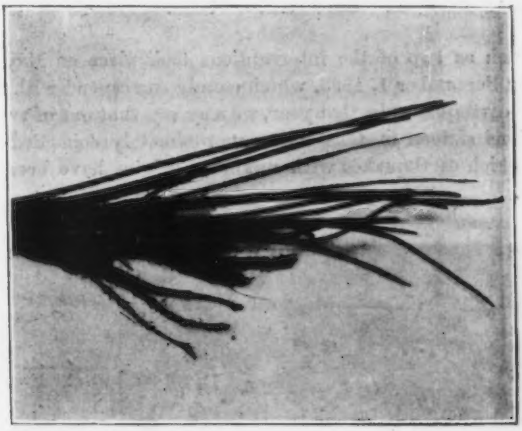


FIG. 9.—WEST COAST OF MOROCCO. BROKEN DECEMBER 26, 1894. THE WIRES ARE CORRODED TO NEEDLE-POINTS.

In the above list the thirty-one interruptions marked with an asterisk took place whilst horizontal pendulums were in operation in or near Europe.

The European observations were as follows:—

September 18, 1889. At Potsdam, 6·92^h to 9·3^h, there was a large disturbance, which suddenly became great at 7·87^h. At Wilhelmshaven the disturbance lasted from 7^h to 9·5^h. The origin is unknown.

September 5, 1889. At Potsdam there was a heavy disturbance at 22·67^h, with a sudden increase at 23·08. At Wilhelmshaven similar phases were at 22·5 and 23·08^h. Large disturbances also with unknown origin were noted on August 29 at 18·48^h.

October 9, 1892. At Strassburg and Nicolaiew, disturbances were noted at about 2·45^h to 2·70^h.

March 3, 1891. At Teneriffe, earthquake at 1·79^h. Origin unknown.

May 21, 1889. At Potsdam, a heavy disturbance at 10·55^h to 11·1^h. Origin unknown.

March 20, 1893. At Strassburg and Nicolaiew, at 5·18^h and 5·27^h. At this time there was an earthquake in Catania.

October 13, 1892. In Strassburg 17·07^h to 17·78^h. An earthquake on the Donau.
September 1, 1893. At Charkow at 9.35 a.m.
February 12, 1894. At Charkow, a strong disturbance at 1^h 35^m.
March 24, 1894. At Charkow, about this time, exceedingly heavy disturbances were recorded, from 17^h 35^m on the 21st to 2^h 48^m on the 22nd; from 9^h 35^m on the 22nd to 3^h 35^m on the 23rd; and on the 24th, from 0^h 26^m to 1^h 2^m.
July 22, 1894. At Charkow, from 11^h 35^m to 17^h 35^m.
October 9, 1895. At 13^h 26^m, slight.
July 8, 1896. At 14^h 54^m and 17^h 46^m at Shide.
October 6, 1896. 21^h 51^m at Shide.
May 5, 1897. 10^h 44^m at Shide.
December 2, 1896. At Shide, 10 a.m. to 11 a.m.

Inasmuch as two of the interruptions took place on May 22, 1889, and two on September 1, 1893, which closely correspond with the unfelt but heavy earthquakes in that year, we may say that out of twenty-nine interruptions sixteen of these have approximately coincided with the times at which earthquakes with unknown origins have been recorded in Europe.

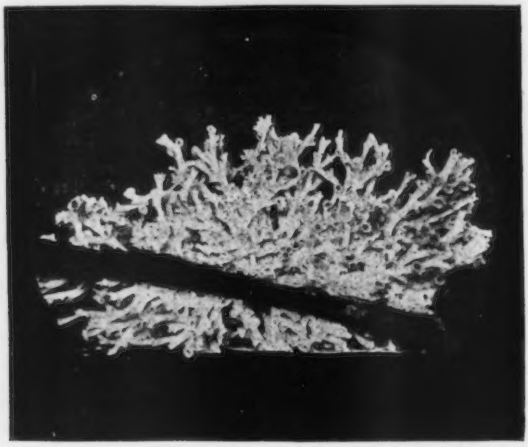


FIG. 10.—CABLE GROWN ROUND WITH CORAL.

Because on the Para—Maranham section * interruptions have been frequent in October, November, and December, and on the Maranham—

* "The Para—Maranham cable is," I believe, a friend writes me, "laid on a shallow muddy bottom, the mud being so fluid that it is said that a schooner with a fair wind can make a good passage when half in mud and half in water." If this is so, then the Amazon floods may have much to answer for in connection with cable-interruption.

Ceara section in November and in March, in searching for the cause of these interruptions we should look to variations in ocean currents or phenomena with a seasonal change.

West Coast of Europe and Africa: Mediterranean.—Interruptions have taken place on the following dates:—

Lipari—Milazzo.—December 1, 1888; March 30, 1889 *; September 15, 1889 *; February 9, 1893 *.

Zante—Canea.—March 29, 1885.

Patras—Corinth.—September 9, 1888; August 25, 1889 * (two interruptions).

The earth-movements which were observed at corresponding times were as follows:—

March 28, 1889. At 7·35^h at Wilhelmshaven, fairly large.

September 13, 1889. At 5·50^h at Potsdam and from 7^h to 9·5^h at Wilhelmshaven.

February 9, 1893. At Strassburg 6·23^h to 8·48^h and at Nicolaiew 6·19^h to 8·07^h, heavy movement. The epicentre possibly near Samothrace. Two other earthquakes were noted on this day.

August 25, 1889. At Potsdam at 7·62^h and at Wilhelmshaven from 7·53^h to 9^h, a large disturbance. Epicentre near Patras.

The Lipari—Milazzo fractures took place in depths of from 400 to 650 fathoms, 2 or 3 miles distant from Vulcano, about north-east from Solfatore.

The Zante—Canea interruption occurred about 5 miles west by south off Sapienza island, in a depth of 1500 fathoms with a clay bottom. Soundings varied as much as 250 fathoms in the length of the ship, and from 1350 to 1834 fathoms in half a mile.

The first of the Patras—Corinth breaks occurred about 2 miles north of Akrata, in mud at a depth of 197 fathoms, whilst one of the second interruptions took place in the same locality, in depths varying between 408 and 270 fathoms within a mile, and the other, in cable No. 2, within half a mile south of Morno point.

Mr. W. G. Forster, writing in the *Transactions of the Seismological Society*, vol. xv., respecting these districts, tells us that after the Filiatra shock in 1886, it was found, by the broken cable 30 miles away, that some 4 knots of the same had been covered by a landslip, whilst the depth of the water had increased from 700 to 900 fathoms. In 1867, after the destruction of Cephalonia, the soundings taken after the shock were different to those taken before. Again, on September 9, 1888, at 5.4 p.m., the town of Vostizza, in the Gulf of Corinth, was destroyed, and simultaneously the cable between Zante, Patras and Corinth was interrupted. The cause of this, as deduced from soundings and the appearance of the fractured cable, appears to have been either a sudden tautening caused by the sweeping down of a mass of clay from a 100-fathom bank to a 300-fathom bank, or the actual yielding of the bed on which the cable lay.

In 1889 a second cable was laid down in the Gulf of Corinth, but this,

when it had been down about three months, was, together with the 1884 cable, fractured at the time of an earthquake on August 25 at 8.51 p.m. The 1889 cable seemed to have been smashed by the movement of a mass of material about a mile in length, whilst the 1884 cable was broken at two points by a slip from a 10 to a 450 fathom bottom.

In the districts considered by Mr. Forster, there are, as he points out, great irregularities in submarine contours, the depths within short distances changing from 50 to 300 and then to 1600 fathoms. By the deposition of silt, and the undermining of steep slopes by bottom currents, the exit of underground springs and even rivers, overhanging shelves, tottering and precipitous rocks, and other unstable arrangements, may suddenly give way and cables suffer rupture.

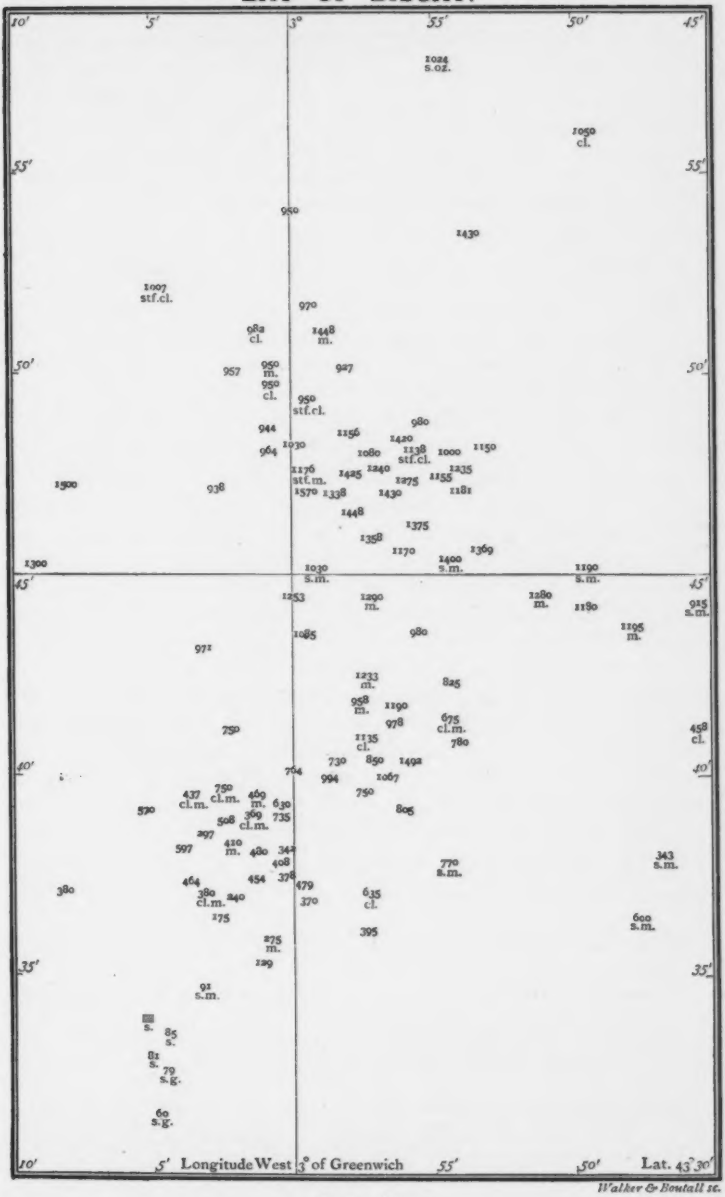
The facts are that the sub-oceanic contours are such that they might be expected to be unstable, and that these contours, at the time of earthquakes, have suddenly been changed. In one instance there has been an increase in depth of over 2400 feet, and in another of 1200 feet; whilst in the case of the 1889 disturbance, eleven and a half minutes later, unfelt earth-waves of considerable magnitude were recorded at Wilhelmshaven, 1732 kilometres distant. Similar unfelt movements have also been recorded at distant places at about the time when cable-interruptions took place, *in every instance* where we have been able to make comparisons. The conclusion, then, is that in this region earthquakes occur, producing beneath the ocean what is equivalent to the landslips which similar movements produce on land.

Bay of Biscay.—About 1875 the Direct Spanish cable was broken about 150 miles north of Bilbao by what seemed to be a submarine landslip, which may have been produced by an undercurrent produced by the piling up of the surface waters under the influence of a westerly gale. The soundings showing the neighbourhood of the interruption indicate slopes of 1 in 7 and even 1 in 3, and it is therefore a district in which landslides and dislocations might be expected to occur (Fig. 11). From Mr. R. Kaye Gray I learn that the 1872 Bilbao cable broke down periodically—usually in the month of March, with or after a heavy north-west gale. This took place about 30 miles to the north of Bilbao, and, when repairing, it was invariably found that 4 or 5 miles had been buried. The cause of these interruptions was attributed to a heavy submarine current caused by the piling-up of surface water, cutting the prolongation of a river-bed with steep walls which, when undercut, fell in masses to bury the cable.

St. Thomé—St. Paul de Loanda.—Interruptions which have been noted on this section were as follows:—

January 22, 1892; September 13, 1892 *; November 24, 1892 *; February 17, 1893 *; April 11, 1893 *; May 30, 1893 *; February 5, 1894 *; January 22, 1895 *; January 15, 1896 *; May 2, 1896 *; June 15, 1896 *.

BAY OF BISCAY.



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Nautic Miles

0 5 10

FIG. 11.

The dates on which unfelt earthquakes were recorded were as follows :—

September 13, 1892. At Strassburg a very large disturbance from $9{\cdot}54^h$ to $13{\cdot}31^h$. Origin unknown.

February 16, 1893. At Strassburg at $0{\cdot}08^h$. Origin possibly in Japan.

April 11, 1893. At Strassburg and Nicolaiew, $18{\cdot}58^h$ to 19^h. Moderate. On April 8 at these stations there was a heavy movement from $1{\cdot}87^h$ to $4{\cdot}17^h$. Origin unknown.

May 30, 1893. At the above stations from $4^h\ 33^m$ to $5^h\ 32^m$; a great movement.

February 5, 1894. At Charkow from $4^h\ 54^m$ to $10^h\ 34^m$ there was a strong movement.

January 18, 1895, $2^h\ 37^m$. At many places in Italy.

January 15, 1896, $7^h\ 10^m$. At many places in Italy.

May 2, 1896, $1^h\ 20^m$. Strong through Europe.

June 13, 1896, $14^h\ 54^m$. Strong through Italy.

June 14, 1896, $22^h\ 46^m$. Strong in Shide and over Europe. Origin in the Pacific ocean.

We have, therefore, eleven cases of interruptions, on or near to the dates of nine of which large earthquakes were recorded. It is difficult to imagine that this particular district should be characterized by any seismic activity, but it seems possible that, if it is a district where sediments rapidly accumulate to attain an unstable form, these might from time to time give way under the influence of earth-waves originating at a great distance.

On this particular section Mr. R. Kaye Gray points out that, from the mouth of the Congo, extending seawards, there is a difficult gully to cross, the walls of which are 2000 feet in height! Although the gully widens towards the west, this height is maintained for a considerable distance. The shallowest water is found along the edges of this gully, which therefore has a transverse section not unlike that of a river bounded by a naturally formed *levée*.

The East Coast of Africa.—The following are interruptions noted in various cable sections along the east coast of Africa :—

Mozambique—Zanzibar.—February 1, 1885; April 2, 1885; September 26, 1894*.

Delagoa Bay—Durban.—October 15, 1890; November 18, 1890; December 10, 1894; January 20, 1896 *; July 13, 1896 *.

Mozambique—Delagoa Bay (Lorenzo Marquez).—November 11, 1890; November 18, 1890; January 5, 1893 *; January 25, 1893 *: June 9, 1895 *; December 24, 1896 *.

Zanzibar—Mombasa.—December 20, 1890; January 25, 1892; September 4, 1894 *; September 26, 1894 *; March 6, 1896 *; August 23, 1896 *; September 23, 1896 *.

Aden—Zanzibar.—January 8, 1890; May 11, 1891; December 5, 1891; February 20, 1893 *; August 9, 1893 *; December 21, 1894; September 2, 1895 *; December 24, 1895 *; January 27, 1896 *; March 16, 1896 *; March 23, 1897 * (?).

With the nineteen interruptions marked with an asterisk, there are eleven instances where these *may* have corresponded with the records of unfelt earthquakes. Approximate coincidences with earth-movements are as follows:—

January 22, 1893, at 19·87^h. A weak disturbance was noted at Nicolaiew and Strassburg.

September 1, 1894, from 1^h 43^m to 4^h 21^m. Moderate at Charkow.

September 25, 1894, 16^h 49^m to 17^h 8^m. At Charkow.

February 20, 1893, from 19·23^h to 19·78^h. At Strassburg small, origin in Japan.

August 9, 1893, from 17^h 81^m to 19^h 4^m. At Strassburg, moderate.

March 3, 1896, at 16^h 33^m. Recorded through Europe.

August 21, 1896, at 10^h 0^m. Recorded at Padua.

September 2, 1895. At 1·3^h to 9·6^h and 19^h at Shide.

March 15, 1896. 19^h 36^m at Shide.

September 21, 1896, at 16^h 53^m. Recorded through Europe.

March 23, 1897. At Shide at 4·29^h, slight.

Sir James Anderson, in 1887, speaking about the interruptions off the river Rovuma (11° S. lat.), remarks that, so far as soundings showed, there was an even bottom and all that could be desired as a bed on which to place a cable, yet every year the cable broke. The broken ends suggested that the cable had been suspended until it snapped. Although the cable was shifted further out, and then closer in, it still broke. This happened eight times, and it was noticed that the interruptions occurred at about the same time of the year. Seven of these breaks are fairly on the same line, and Sir James's suggested explanation of this cause was that the time when the interruptions occur is at the termination of the rainy season in the African mountains, at which time fresh-water springs take away the bottom on which the cable lies, and leave it suspended.

Mr. John Y. Buchanan suggests that sometimes a cable may be broken in consequence of its slowly subsiding through ooze, until the catenary strain becomes so great that it eventually snaps.

Aden—Bombay.—Interruptions noted on this section were the fol lowing:—

July 11, 1881; June 3, 1885; July 27, 1885; July 11, 1888; August 11, 1888.

On the second and last of the above dates the two cables connecting Aden with India were simultaneously broken, and the traffic between India, Australia, and the East had to pass over the land lines of Russia, Persia, and Turkey. The fractures took place on an even bottom a few hundreds of miles from Aden. At the time of the 1885 interruption, a fearful cyclone was raging at Aden, and it is therefore possible that the ruptures may be attributed to causes similar to those which seem to have operated on the Bilbao cables. The place of fracture was 119 knots

from Aden, 20 to 25 miles south of the Arabian coast, at a depth of 870 to 990 fathoms, on an even bottom of mud.

Penang and Madras.—Interruptions noted on this section have been as follows :—

May 12, 1873; November 15, 1875; March 28, 1876; November 9, 1878 April 22, 1880; January 31, 1881; June 6, 1883; November 15, 1883; June 13, 1884; September 2, 1886; November 2, 1886; November 14, 1886; September 22, 1888 (?); May 13, 1890.

On the above dates horizontal pendulums or the equivalent instruments were not in operation, but that these interruptions were partly due to sub-oceanic change may be inferred from the fact pointed out by Sir John Pender in the *Electrical Review* of May 23, 1890, who says that nearly all the interruptions on this line have taken place on very bad ground near the Nicobar islands.

South-East Parts of Asia.—The following completes the list of interruptions on far eastern lines :—

Rangoon—Penang.—September 4, 1886; May 13, 1890.

Singapore—Penang.—November 20, 1873; August 7, 1876; November 8, 1876; December 20, 1876; July 20, 1877; October 19, 1877; September 30, 1878.

Batavia—Singapore.—March 31, 1873 (?); May 20, 1874 (?); August 13, 1874; August 18, 1874; December 14, 1874; September 2, 1875; November 5, 1875; May 9, 1876; June 28, 1876; October 25, 1876; February 27, 1877; September 28, 1877; November 9, 1877; January 22, 1878; May 2, 1878; August 31, 1878; October 28, 1878; December 28, 1878; September 20, 1879; December 3, 1883.

Port Darwin and Java (Banjoewanji).—June 21, 1872; April 27, 1876; November 8, 1877; September 27, 1878; May 29, 1879 (?); July 4, 1879; March 5, 1883; March 10, 1883; April 6, 1883 (?); October 22, 1883; June 29, 1888 (two cables broken); October 10, 1888 (both cables broken); October 22, 1888 (both cables broken); July 11, 1890 * (three cables broken, one being to Roebuck bay); February 23, 1893 *; March 22, 1893 *; September 27, 1893 *; October 25, 1893 * (two cables broken, see *Electrician*, November 3, 1893); October 26, 1893 *.

The horizontal pendulum records are as follows :—

February 22, 1893. At Strassburg, $11{\cdot}28^h$ to $11{\cdot}78^h$; also at Nicolaiew. Moderate.

March 20, 1893. At Strassburg, $5{\cdot}18^h$ to $5{\cdot}53^h$; also at Nicolaiew. Moderate. Origin probably in Zante.

September 11, 1893. At Charkow, $16^h\ 13^m$ to $17^h\ 50^m$.

October 22, 1893. At Charkow, 13^h.

The two fractures of June 29, 1888, took place 20 and 25 miles south by west of Mount Dodo, Sumbawa, where depths vary from 734 to 1130 fathoms. Sir John Pender, at the ordinary general meeting of the Eastern Extension Australasia and China Telegraph Company (see *Electrician*, October 12, 1888), says that it was found that these breaks resulted from "volcanic" action, and, curiously enough, when the cables were recovered, all sorts of things, even the roots of trees, were found attached to them. The whole thing seemed to be a great upheaval of nature. From the same paper, August 20, 1888, we learn that these two

interruptions took place at points widely separated. In Port Darwin time, the fractures took place on June 29, at 10.40 p.m. The three interruptions of July 11, 1890, took place, in Banjoewanji time, at 1.35 a.m., on a rough, uneven bottom, between Tafel Hoek (Bali) and Balambangan point, Java, where the depths vary from 155 to 927 fathoms. The duplicate cable was broken in three places, and overlaid about 65 miles from Banjoewanji. The three cables run along two sides and near the bottom of a gully separating Baly from Java, and are about 7 miles apart. They practically broke on one line, and the cause was "volcanic" action (see *Electrician*, October 24, 1890, vol. xxv.). In this instance, as in that of June 30, 1888, the submarine displacements extended over an unusually wide area, and when we refer to a chart, it is seen that at a distance of 9 miles in a south-west direction from Tafel Hoek there is depth of 1180 fathoms, indicating a slope of 1 in 7.

The only interruptions which can be compared with the records of horizontal pendulums are the last five. The time of the interruption of March 22, 1893, is not known. The mean Greenwich times and dates at which the remaining four took place in 1893, are as follows:—

1. February 22, between $4^h\ 20^m$ and $16^h\ 20^m$.
2. September 12, $12^h\ 20^m$.
3. October 24, $17^h\ 5^m$.
4. October 26, $3^h\ 0^m$.

The conclusion is, that only the first of these four interruptions took place when an unfelt earthquake was recorded in Europe, but similar disturbances were noted on September 11 and October 22.

The following table is a comparison of the days and hours when earthquakes were felt in Java, with the times at which cables were interrupted:—

Shocks felt in Java and Sumatra in *approximate* G.M.T. (Batavia time – 7 hours).	Date and G.M.T. of cable-interruptions.
1872, June 16, 12^h to 14^h	June 21
1876, April 23, $10^h\ 15^m$. Sumatra	April 27
1877, November 3 to 4	November 8
1878, September 21, $19^h\ 30^m$. Sumatra	September 27
1879, without records	
1883, March 6, $4^h\ 45^m$. Sumatra	March 5
1883, October 18, $17^h\ 0^m$. Banjoewanji	October 22
1888, June 29, $21^h\ 33^m$. Batavia	June 29, $3^h\ 40^m$
October 8, $12^h\ 18^m$. Series of shocks October 9, $12^h\ 26^m$	October 9
October 21, $12^h\ 5^m$. Light shock	October 22
1890, July 10, $16^h\ 50^m$ to $19^h\ 40^m$. Series of shocks, some heavy. Java	July 11, $6^h\ 35^m$
1893, February 23, $15^h\ 15^m$. Java	February 23, $4^h\ 20^m$ and $16^h\ 20^m$
March 22, $13^h\ 32^m$. Light. Java	March 22 (time unknown)
September 9, $22^h\ 57^m$. Moderate. Java	September 27, $12^h\ 20^m$
October 23, $9^h\ 53^m$. Fifteen shocks, very heavy. Java October 25. A light shock	October 25, $17^h\ 25^m$

For the interruptions of cables on June 29, 1888, and July 10, 1890, we have the assurance of those connected with their management that the cause was volcanic or seismic, whilst the actual or close coincidence in the dates at which the remaining interruptions have taken place with the days on which earthquakes have been felt leads to the belief that the Port Darwin—Java section has suffered more from the effects of sudden sub-oceanic change than from any other cause. The European records of February 22 evidently refer to the disturbance which caused the interruption on that date in Java, between the hours 4·20^{h} and 16·20^{h}.

A Tabular Arrangement of the Foregoing Interruptions.

Name of cables.	Jan.	Feb.	Mar.	Ap.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
North Atlantic	—	—	—	1	—	3	3	—	3	4	—	—	14
St. Louis—Fernando Noronha	—	—	1	—	—	—	—	—	—	—	—	1	2
Pernambuco—Cape Verde	—	—	—	—	—	—	—	—	1	—	—	—	1
La Libertad—Salina Cruz	—	—	—	—	—	—	—	—	—	—	1	—	1
Panama—San Juan del Sur	—	—	—	—	—	1	1	—	—	—	—	—	2
Sta Elena—Buenaventura	1	1	—	—	—	—	—	1	—	—	—	4	7
Paita—Sta. Elena	—	—	1	1	3	—	—	—	2	—	—	—	7
Mollendo—Chorillos ...	1	2	4	1	—	2	—	2	—	1	—	2	15
Arica—Mollendo	—	—	—	—	1	2	1	1	—	—	—	—	5
Iquique—Arica	—	—	—	—	2	1	—	—	—	—	—	—	3
Caldera—Antofagasta ...	—	—	—	—	—	—	1	—	—	—	—	—	1
Valparaiso—Serena ...	—	—	—	—	—	—	3	2	—	—	—	—	5
Montevideo—Buenos Ayres	—	—	—	—	—	—	—	—	—	1	—	—	1
Sta Catharina—Rio Grande do Sul	—	—	—	—	—	1	—	—	—	—	—	—	1
Santos—Sta. Catharina ...	—	—	1	—	—	—	—	—	—	—	—	—	1
Montevideo—Rio Grande do Sul	—	—	—	1	1	1	—	—	—	—	—	2	5
Chuy—Montevideo ...	—	—	—	—	—	1	1	—	—	—	1	—	3
Rio de Janeiro—Santos ...	—	—	—	2	—	—	—	—	—	—	—	1	3
Bahia—Rio de Janeiro ...	1	—	—	—	—	—	2	—	3	—	—	—	6
Pernambuco—Bahia ...	—	—	—	1	—	—	2	—	—	—	—	—	3
Ceara—Pernambuco ...	1	—	3	1	—	—	—	—	1	—	—	—	6
Maranham—Ceara	2	1	3	2	1	—	—	—	—	1	2	1	13
Para—Maranham	4	1	2	—	2	—	2	2	2	4	4	4	27
Lipari—Milazzo	—	1	1	—	—	—	—	—	1	—	—	1	4
Zante—Canea	—	—	1	—	—	—	—	—	—	—	—	—	1
Patras—Corinth	—	—	—	—	—	—	—	1	1	—	—	—	2
St. Thomé—St. Paul de Loanda	3	2	—	1	2	1	—	—	1	—	1	—	11
Mozambique—Zanzibar ...	—	1	1	—	—	—	—	—	1	—	—	—	3
Delagoa Bay—Durban ...	1	—	—	—	—	—	1	—	—	1	1	1	5
Mozambique—Delagoa Bay	2	—	—	—	—	1	—	—	—	—	2	1	6
Zanzibar—Mombasa ...	1	—	1	—	—	—	—	1	3	—	—	1	7
Aden—Zanzibar	2	1	1	—	1	—	—	1	1	—	—	3	10
Aden—Bombay	—	—	—	—	—	1	3	1	—	—	—	—	5
Penang—Madras	1	—	1	1	1	2	—	—	2	—	5	—	13
Rangoon—Penang	—	—	—	—	1	—	—	—	1	—	—	—	2
Singapore—Penang ...	—	—	—	—	—	—	1	1	—	1	2	1	6
Batavia—Singapore ...	1	1	1	—	3	—	—	3	3	2	2	3	19
Port Darwin—Java ...	—	1	3	2	1	2	2	—	2	5	1	—	19
	21	12	25	14	19	19	23	16	28	20	22	26	245

The foregoing table is a list of the thirty-eight lines just discussed along which one or more cables are laid. Since these lines were established, the number of interruptions which have occurred have been *at least* 245. For certain lines it would appear that fractures were more frequent at one season than at others, and that therefore a proper analysis of the table or its parts, such, for example, as those to which earthquake statistics have been subjected, might lead to the discovery of periodicities in cable-interruptions. Unfortunately, because the material in our possession is yet so meagre, such discussions must for the present be reserved.

Out of the 245 breaks, 87 of them, each marked with an asterisk, occurred at the times when instruments were in operation which would record unfelt earthquake effects. Fifty-eight of the 87 cable interruptions occurred at or about the times when Europe was agitated by these unfelt movements. The fractures accompanying earthquake, or, as it is sometimes called, volcanic movement—which could be felt, and which in two instances caused destruction on neighbouring shores, were at least 10 in number. The Java records might possibly raise this number to 24. In three of these instances, two or three cables were broken simultaneously, and in these cases, the submarine dislocations extended over a wide area; in the Gulf of Corinth great changes in ocean depth were brought about, and from this latter place we know the motion to have radiated, so that a few minutes after the interruption well-defined diagrams of earth-waves were obtained at localities 1000 miles distant, at places where no movement could be felt.

Instances like the latter clearly establish a connection between cable-interruptions, earthquake-motion which has been felt, submarine dislocation, and the records of horizontal pendulums in distant localities where earth-movements have not been felt. This being the case, and because earthquake-motion cannot be felt at great distances from its origin, it is reasonable to conclude that the records of unfelt earthquakes which approximately coincide in time to those at which cables have been interrupted *may* sometimes indicate that submarine geological changes have accompanied seismic efforts.

Although certain conclusions arrived at in this paper are definite, until the materials necessary for analysis can be obtained, others remain matters of inference. The records of interruptions for the lines mentioned are, we have reason to believe, incomplete. The horizontal pendulum records with which to make comparisons have not only been few in number, but, because they are confined to Europe, could only be expected to throw light upon disturbances originating at a great distance which were exceptionally large. The records of earthquakes which have been felt are confined to an imperfect list for Java, a few from the Mediterranean, and a few reported from the west coast of South America. Lastly, the hours, and in some cases even the days, on which cable

interruptions have taken place, together with the probable cause of these interruptions, are unknown. These latter facts are no doubt to be found in the archives of many cable companies, and it would be to the interest of all who desire to increase our knowledge of sub-oceanic change if comparisons could be made between the records of unfelt earthquakes now published, and the times and circumstances at and under which corresponding cable-ruptures have taken place.*

All that it is expected to find is, that a certain and probably a small proportion of these interruptions may correspond in time with seismic disturbances, and, because we know that certain cables have been lost by landslips and dislocations accompanying earthquake-movement, it is to be hoped that the expectation may be regarded as a reasonable conjecture.

An Attempt to estimate the Frequency of Submarine Dislocations.—If it can be assumed that the majority of cable-interruptions are due to submarine displacements, and not to faults inherent in the cables themselves (which are comparatively of rare occurrence), the swaying of suspended sections under the influence of waves and currents, the movements of marine creatures, the boring of a *teredo*, and other exceptional causes, then the tables which have been given of cable fractures will give some idea of the frequency of such displacements. Because the list of interruptions for a number of the lines mentioned are imperfect, and because each cable follows a path carefully chosen as not being likely to suffer from submarine disturbance, the frequency of dislocation derived from such an assumption is more likely to be a minimum than a maximum. From the known number of interruptions which have occurred on sections of given length in a given number of years, the table (p. 281) of dislocation frequency per mile of coast per year has been computed.

The coasts taken are the east and west sides of South America and Africa. The total length considered representing shores which are steep and those which are gently inclined is about 11,000 miles. The general result which is reached is that the dislocations per mile per year, on the coast-lines considered, which may be taken as having on the average a character similar to that of the coast-lines of the world, are represented by the number 0·0023, that is to say, there is on the average, one dislocation for every 434 miles per year. If we increase this number to 500 miles, and remember the character of the records and that of the facts to which they refer, although we have attributed *all* the interruptions to submarine change, we are inclined to the opinion that the estimate is not too great. This being granted, then, as there are about 156,000 miles of coast-line in the world, if the same were surrounded by loops of cables, although each section might be laid in

* The writer, whose address is Shide Hill House, Newport, I.W., England, would be glad to receive any information respecting the day, hour, and probable causes of failure, connected with cable-interruption.

the most favourable position, more than three hundred interruptions resulting from submarine disturbance might be expected to occur every year. In deep water on a level soft bottom experience shows that a

CABLE DISLOCATION PER MILE PER YEAR.

Name of cable.	Length in nautical miles.	Number of breaks per mile per year.
Mollendo—Chorillos	510	0·002
Arica—Mollendo	146	0·003
Iquique—Arica	128	0·0040
Antofagasta—Iquique	250	0·0000
Caldera—Antofagasta	229	0·0004
Coquimbo—Caldera	215	0·0000
Valparaiso—Coquimbo	219	0·001
Santos—Chuy	744	0·000
Maldonado—Montevideo	72	0·000
Chuy—Maldonado	125	0·000
Rio Grande do Sul—Chuy	148	0·000
Monte Video—Buenos Ayres	32	0·004
Sta Catharina—Rio Grande do Sul	397	0·0004
Santos—Sta Catharina	293	0·0005
Montevideo—Rio Grande do Sul	349	0·006
Chuy—Montevideo	201	0·001
Rio de Janeiro—Santos	223	0·009
Bahia—Rio de Janeiro	768	0·0011
Pernambuco—Bahia	404	0·0036
Ceara—Pernambuco	481	0·0018
Maranham—Ceara	408	0·004
Para—Maranham	381	0·008
St. Thomé—St. Paul de Loanda	785	0·003
Delagoa bay—Durban	348	0·002
Mozambique—Delagoa Bay	971	0·001
Zanzibar—Mombasa	150	0·007
Aden—Zanzibar	1914	0·0008
	10,891	0·0023 average.

cable may remain undisturbed and unchanged for long periods of time, indicating, as we have already pointed out, that geological change is proceeding with extreme slowness.

SECTION IV.

Conclusions and Suggestions for a Seismic Survey of the World.

Because earthquake origins are more numerous beneath the sea than upon the land, it is fair to assume that the bradyseismical operations resulting in the folding, bending, crushing, faulting, and thrusting of rock masses are more active in the recesses of the ocean than they are upon our continents. Sub-oceanic volcanic activity, as, for example, that which is met with in the mid-Atlantic, probably indicates the existence of bradyseismic movement and a relief of strain. The concentration of detritus derived from continental surfaces along coast-

lines on tracts which are comparatively small, indicates that beneath the sea the growth by sedimentation is greater per unit area than the similarly estimated loss is by denudation on the land. This rapid submarine growth, largely under the influence of gravity, but modified by hydrodynamic action, leads to the building up of steep contours, the stability of which may be destroyed by the shaking of an earthquake, the escape of water from submarine springs, the change in direction or intensity of an ocean current, or by other causes which have been enumerated. That submarine landslides of great magnitude have had a real existence is proved for certain localities by the fact that after an interval of a few years very great differences in depth of water have been found at the same place, whilst sudden changes in depth have taken place at the time of and near to the origin of submarine earthquakes (see p. 272). Large ocean waves unaccompanied by volcanic action indicate that there have been very great and sudden displacements of materials beneath the ocean. The most important evidence of sub-oceanic change is, however, to be found amongst the archives of the cable engineer. The routes chosen for cables are carefully selected as being those where interruptions are least likely to occur, and yet, as it has been shown, something which is often of the nature of a submarine landslip takes place and some miles of cable may be buried. Here we seem to have proof positive, especially along the submerged continental plateaus, of sudden sub-oceanic dislocation. Because these changes are frequent, it is reasonable to suppose that sedimentation and erosion, and other causes which lead up to the critical conditions, are geologically rapid.

Briefly, the foregoing notes and facts indicate that beneath the oceans certain important geological changes are more rapid than they are upon land, whilst new sources from which information respecting these changes may be obtained are pointed out to the student of dynamical geology.

The more important of these sources are the experiences of the cable engineer and the records of seismographs, which are sensitive to unfelt movements. When a number of these instruments have been established round the world, on the borders of great oceans, and on oceanic islands, it is difficult to overestimate the practical and scientific results which will follow.

The greater number of records, as it has been shown, would refer to disturbances which originated beneath the sea. From the times at which earth-waves arrived at different stations, as, for example, on the two sides of the Atlantic, it would be possible to localize their origins, and in time districts would be indicated which it would be well for those who lay cables to avoid. Work of this nature has, by means of ordinary seismographs, been *partially* accomplished for Japan, and the seismic maps of that country (see *Seism. Jour.*, vol. iv.) show that sub-oceanic disturbances originating *near to the coast* are herded in groups.

Should a trans-Pacific cable be landed in that country, to effect this through the middle of one of these groups would be inviting its destruction.

If we had the means of knowing that when an interruption occurred in a cable at the same time an unfelt earthquake had been recorded, we should then be in a position to attribute the fault to its proper cause. The practically simultaneous failure of three Atlantic cables in 1884 led to the hypothesis that they had been broken by the grapnels of a repairing vessel; fortunately for the owners of this vessel, it could not be substantiated.

From the *Electrician* of August 20 and October 12, 1888, we learn that the simultaneous interruption of the two cables connecting Java and Australia in 1888 cut off the latter from the outside world for nineteen days, and gave a pretext for calling out the military and naval reserves to meet the contingency of war having broken out. In 1890 three cables were simultaneously broken, and telegraphic communication with Australia was cut off for nine days. On these occasions, had there been established in Australia a proper instrument for recording unfelt movements of the ground, it is extremely likely that the cause of the interruption would have been recognized as due to seismic action, and the fear of war and the probable accompanying commercial paralysis would have been averted. Other direct benefits, which have already been derived from the records of instruments such as it is here proposed to establish round the world, are that they enable us to extend, correct, and even to cast doubt upon certain classes of telegraphic information published in our newspapers.

Late in June last year we learned from our newspapers that a great disaster had taken place in North Japan, and that nearly 30,000 people had lost their lives. Seismograms taken in the Isle of Wight not only indicated how many maxima of motion had taken place, but showed that there had been an error in transmission of two days, the catastrophe having taken place on the evening of June 15, so that all who were to reach the stricken district after that date were in safety.

On August 31 of the same year, the Isle of Wight records showed that a disturbance similar to that which had occurred in Japan had taken place. On account of this similarity, it was stated that we should probably hear of a great earthquake having taken place in or near that country on the above date at 5.7 p.m. Four weeks later this was verified by mail. Another instance occurred some weeks later, when our newspapers announced that a great earthquake had taken place and several thousand lives had been lost in Kobe. No doubt those who had friends and property in that city were filled with anxiety. On this occasion the Isle of Wight instruments were still indicating that nothing of the magnitude described could have occurred. Later it was discovered that the telegram was devoid of all foundation.

If we next turn to the scientific aspect of the proposed investigations, we at once recognize the importance of the results which it is hoped may be obtained for the hydrographer and the student of physical geography and geology.

The greatest result which it is hoped may be achieved is to accurately determine the rate at which earthquake motion is propagated over long distances. In some instances the rates which have already been determined are so high, reaching 12 and more kilometres per second, that the supposition is, that motion does not simply go round our Earth, but that it goes *through* the same, and if this is so, then a determination of these rates of transit will throw new light upon the effective rigidity of our planet.

That these suggestions have been well considered is testified by the issue of the following circular, copies of which have already been forwarded to certain countries by the Foreign Office:—

SEISMOLOGICAL INVESTIGATION.

COMMITTEE APPOINTED BY THE BRITISH ASSOCIATION.

Lord Kelvin, F.R.S.
Prof. W. G. Adams, F.R.S.
Dr. J. T. Bottomley, F.R.S.
Sir F. J. Bramwell, Bt., F.R.S.
Prof. G. H. Darwin, F.R.S.
Mr. Horace Darwin.
Major L. Darwin.
Dr. C. Davison, Secretary.
Mr. G. F. Deacon.
Prof. J. A. Ewing, F.R.S.
Prof. C. G. Knott.
Prof. A. G. Lebour.
Prof. R. Meldola, F.R.S.
Prof. J. Milne, F.R.S., Secretary.
Prof. J. Perry, F.R.S.
Prof. J. H. Poynting, F.R.S.
Dr. Isaac Roberts, F.R.S.
Mr. G. J. Symonds, F.R.S., Chairman.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Burlington House,
London, W.

———, 1897.

To———————

———————

SIR,

It has been established that the movements resulting from a large earthquake originating in any one portion of our globe can, with the aid of suitable instruments, be recorded at any other portion of the same; therefore, the Seismological Investigation Committee of the British Association are desirous of your co-operation in an endeavour to extend and systematize the observation of such disturbances.

Similar instruments should be used at all stations; and the one recommended by this Committee as being simple to work, and one that furnishes results sufficiently accurate for the main objects in view, is indicated in the accompanying report.*

* The report referred to will be found in the 'Reports of the British Association for 1896,' pp. 180–231. There is a sketch of the instrument on p. 187, and an example of a record on p. 229.

We desire to know whether you are disposed to purchase, and make observations with, one of these instruments, the cost of which, including photographic material to last one year, packed for shipment, is about £50. Should you reply in the affirmative, we shall be pleased to arrange with a competent maker for the construction of an instrument for you, and to furnish instructions respecting installation and working. In case an instrument be established at your observatory, we should ask that notes of disturbances having an earthquake character be sent to us for analysis and comparison with the records from other stations. From time to time the results of these examinations would be forwarded to your observatory.

The first object we have in view is to determine the velocity with which motion is propagated round or possibly *through* our Earth. To attain this, all that we require from a given station are the times at which various phases of motion are recorded; for which purpose, for the present at least, we consider an instrument recording a single component of horizontal motion to be sufficient. Other results which may be obtained from the proposed observations are numerous.

The foci of submarine disturbances, such, for example, as those which from time to time have interfered with telegraph cables, may possibly be determined, and new light thrown upon changes taking place in ocean beds.

The records throw light upon certain classes of disturbances now and then noted in magnetometers and other instruments susceptible to slight movements, whilst local changes of level, some of which may have a diurnal character, may, under certain conditions, become apparent.

Trusting that you will find it possible to co-operate in this endeavour to extend our knowledge of the Earth on which we live,

We remain, Sir,

(On behalf of the Committee,)

Your obedient servants,

G. J. Symons, Chairman.

C. Davison, } Joint Honorary
J. Milne, } Secretaries.

It is requested that replies be addressed to—

The Seismological Committee,
British Association,
Burlington House,
London, W.

Before the reading of the paper, Admiral Sir W. J. L. Wharton, Vice-President (in the chair), said: Mr. Milne requires no introduction from me, for he has read papers here before, and he has a very important communication to make to us to-night, which I will now ask him to read.

After the reading of the paper, the following discussion took place:—

Sir Archibald Geikie: We have all listened with pleasure to this paper. "All roads lead to Rome," and when I read the title, "Sub-oceanic Changes," I knew that in Mr. Milne's plan of the world every road leads to the earthquake. I was prepared, therefore, to find that sub-oceanic changes were largely of a seismic kind. I have listened with great interest to all that he has said to us with regard to the data he has been able to obtain from the cable companies. I think that is really the important part of the paper. We know so little of what takes place in the deeper parts of the ocean, and only by direct experiment can we obtain the necessary information. The experiments carried on by the cable companies reveal that a good many changes from time to time take place. There is one misapprehension

which I dare say the author did not mean to convey, viz. that earthquakes are mainly submarine, and belong more to the ocean than the land. I don't think that is quite the case, even on his own showing. He told us that the continents begin at the bottom of the continental slopes, and that about the bottom of these slopes earthquakes chiefly take their rise. We have long known that the margins of the continents are critical lines; that geological changes have been apt to take place there more frequently and with greater vigour than elsewhere. Britain, for instance, lies on the margin of the European continent, and I suppose there is no area of the same size on the face of the globe which contains within it so marvellous a record of volcanic action. Going back from comparatively recent to the most remote geological times, the borderland of the continent seems to have been always the most sensitive tract, and it is there that volcanoes and earthquakes have been most apt to occur. When Mr. Milne speaks about earthquakes being more under the sea than on the land, I would modify that statement by saying that, while earthquakes undoubtedly originate under the sea, they nevertheless belong to the great continental uplifts on the face of the globe rather than to the sea-bottom. The bottoms of the great oceans are comparatively quiet, undisturbed regions, except along the lines where submarine ridges occur, and where probably volcanic operations are at work. Then as to another point which the author passed rapidly over—the deposits worn off the face of the land and laid down on the sea-bottom. He spoke of some experiments with an aquarium, by dropping fine sand from a point into the water, and so building up cones. Now, I imagine that when a river or series of rivers enters the sea, the material transported from the land is not thrown down in cones, but spreads out pretty evenly over the sea floor. If you take a wide view of the subject, and make a section across the submarine continental plateau to the great ocean floor beyond, you will find that instead of cones, sheets of sediment, sloping more or less gradually from the edge of the land, are spread out towards the deeper water. It may be that from time to time ocean currents disturb this sediment. We do not know very much about what ocean currents do at any great depth. This is a point on which the cable companies may be able to throw some light. That there may be a good deal of burying and chafing of cables by material heaped on them is probable; Mr. Buchanan has remarked that submarine cables may quietly subside in soft ooze, which, accumulating over them, may cause such a strain on them when they are pulled up as to make them actually break. That the cables may break by fretting against steep slopes of rock of broken and irregular contours, I think highly probable; that this takes place from time to time along the seaward faces of continents seems exceedingly likely. I should like to separate the actual observations which the author has brought before us from the speculations he has founded upon them. All Mr. Milne's speculations are suggestive. You may not perhaps concur with him in every point, but you cannot help feeling that the observations and speculations are those of an observant and thoughtful man. They make you think anew about what you supposed you knew quite well, and, by putting things in another light, open your eyes, and make your mind more ready to receive the fresh information he gives you.

Prof. PERRY: I should have preferred to hear what Mr. Gray has to say; indeed, I have nothing to say on the subject, except that perhaps, if Sir Archibald Geikie would think that Mr. Milne was only imitating in a little bowl or aquarium what occurs in the huge ocean, he will see that the little slope of sand Prof. Milne formed may not be so very dissimilar from the bank formed in the ocean. Prof. Milne has, at two or three lectures where I have heard him, speaking of seismic phenomena, attracted my attention and tried to attract the attention of the

audience to the usefulness of seismic survey. At one time he told us—and I know it is quite true—that these observations he made during so many years have given much useful information as to how to build houses in an earthquake country. Another time he told us another use of these observations. To-night he has been telling us about deep-sea cables, and with regard to these, I would submit, with all deference to Sir Archibald Geikie, that Prof. Milne's idea as to their fracture is surely a reasonable one. When we have three cables many miles apart, of different ages, breaking at the same time, it is very unlikely that their fracture can have been due to their gradual sinking in ooze. In the usefulness of seismic observation in house-building and cable-laying, I am as much a believer as Prof. Milne can want any of his hearers to be, and I grant that he appeals in the right way to a popular audience, but it seems to me that his information is of enormously greater value than he has yet stated.

We live upon a huge object, 8000 miles thick, and we have a small amount of knowledge about its mere skin, say 2 miles of its thickness. Lord Kelvin tells us that it must be very rigid and yet very hot inside; geologists think it must be liquid; men who study magnetism say that they are in a state of perpetual ignorant wonder about the Earth's inside; we all know that, whatever be the state of the matter inside, it must be quite different from that of all stuff known to us. Now, Milne's experiments and observations have not gone very far as yet, but so far as they have gone they show that they can reveal to us some of the Earth's secrets. It is very wonderful that when he sees a record of a distant earthquake, he can tell whether the motion has travelled 7000 miles or only 1000 miles; in the first case the motion being preceded by long-continued tremors, in the latter by tremors lasting only ten minutes. What is the meaning of the enormous velocity of these tremors? 17 kilometres per second! No known property of rock suggests to us a velocity more than a fifth of this. These messages of his have come, not along the surface, but through the body of the Earth; properly observed and studied, they will surely give us information which we at present see no other means of getting. Prof. Milne asks for a seismic survey of the Earth; that these messages which are always being sent shall be recorded at a number of places sufficiently far apart. As a member of the Kew Committee, I gave my voice for the putting up of an instrument near London, and this is now being done. I wish God-speed to Prof. Milne in every effort he makes to induce people to establish receiving-instruments all over the world. If people need to be bribed, if these stations cannot be established unless they are likely to be useful to builders and telegraph people, by all means let us hear about earthquake-proof walls and railway bridges and cables; but I venture to tell this audience that the matter is one of very much greater importance—it concerns not merely our material well-being, but our knowledge of the secrets of nature.

Mr. Matthew H. Gray: I have very little to add to what we have heard to-night from Prof. Milne. I am sure it is a most interesting subject. There are many useful points in these observations which Prof. Milne laid before you, which more concern telegraph companies than those interested in establishing seismic stations. Prof. Milne pointed out that Australia might have known that the cables were broken by earth-movements if they had stations for observing them, instead of doing as they did—call out the troops, put ships into commission, send men to the forts, and generally disturb the whole course of peaceful commerce. He has again pointed out in Japan and its vicinity places where it is unsafe to lay a cable, and places where it is unsafe to land a cable; I understand that at the present time the American Government, or some of the people, are laying a cable from San Francisco to Hawaii and Japan, and there is no doubt that the result of

these observations will be of the greatest assistance and help to those engaged in that work. I don't know that I can say anything on the subject of the cause of earthquakes, as it is rather wide of the matter before the meeting. It has occurred to me that the percolation of water through some of the strata, and its reaching shale or some stratified body which absorbs the moisture, would cause a swelling of this particular stratum, and doubtless that would move the overlying rock. This seems rather a small cause for so large an effect, but one remembers the way in which the granite was broken up in the quarries at Assuan. There is one block half hewn from the quarry, about 100 feet long, where they have dug small holes in a line in the granite, and in these they put wedges of soft wood. Water was then allowed to run in a small channel, and the swelling of the wood parted the granite, although it seems an impossible thing to happen. Therefore I think the swelling of the strata due to the percolation of water is of importance, because very great tension being established in the overlying rocks, when the point of elasticity is reached, the rocks suddenly crack, and create those movements Mr. Milne has spoken of. I can only say that I am very glad to have listened to this paper. It throws a great deal of light on the causes of things of which we know very little, and all interested in submarine cables will be much indebted to Prof. Milne for the light, new in many points, which he has thrown on the subject.

Mr. R. Kaye Gray: I am afraid I cannot say very much on the registration of earth-movements, or how far these are responsible for the interruptions of submarine telegraph cables which lie parallel to shore-lines and across continental slopes. Having considerable experience in cable matters, I can, however, confirm every word Prof. Milne has said as to the continual interruptions of lines laid under these conditions, and can also bear witness that these interruptions are almost always due to submarine landslips. Whether these landslips are caused by earth-tremors, geologists are better able to judge than I; but any one can understand that accumulating slopes of mud or sand must gravitate to the lowest level, and that at certain stages in the accumulation, a state of critical stability is created, which earth-tremors may easily disturb.

I must, on behalf of certain cable companies, thank Prof. Milne for the great care with which he treats questions that are of first importance to us, and for the enormous labour which he has expended in compiling evidence in support of his theories. His work is very useful to the proprietors of cable property, and consequently to the whole world. What the world would be to-day without submarine telegraphic communication—America cut off from Europe, and our colonies cut off from us—is something too terrible to consider, and if any man advances good evidence as to the causes which bring about their interruptions, and thus puts into the hands of the engineers the power of reducing them, he earns public gratitude. If Prof. Milne and other scientific men are working in that direction, it is surely little to ask the public to assist in establishing the seismic observatories which he has so much at heart. So far as I can influence matters, I shall be glad to give him any help that lies in my power.

Admiral Wharton: Prof. Milne has broken such comparatively new ground and covered so much that he certainly has given all of us much food for reflection. It is extremely difficult to sum up in any way what he has put before us, and make any remarks, except brief ones. The subject of sub-oceanic changes is extremely interesting to me, and I don't think I have ever listened to a paper which has suggested more to me than Prof. Milne's. He would not profess himself, I am sure, to say that he has proved all the propositions he has put before us, but with regard to the most interesting one, the most patent thing is that some earthquakes are caused by the sudden slipping down of steep submarine slopes. That would be an

extremely interesting thing to follow up. He has given us the cue, and no doubt attention will be called to that, and at a future time we shall see whether Mr. Milne's theories are true or not. No doubt there are a great many slips under the sea, but I am a little bit doubtful about some of his evidence as to the actual slopes. I am rather more struck by his suggestion—which is not absolutely new, though he has put it in a new way to me—of the breaking out of submarine springs, and a great many telegraph engineers have very strong ideas on the subject of these springs causing the cables to be broken by moving the material along the bottom of the sea. I have never thought that possible to any extent where cables are broken and found buried, and think it more probable that the cables are broken by the slipping of material, as Mr. Milne suggests. I am inclined to think that undermining by submarine springs is as likely to be a fertile source of slipping as earthquakes. I have had the advantage of carefully reading the paper which he has summarized to-night, and he mentions submarine springs as another cause of sub-oceanic changes.

If he succeeds in getting a sufficient number of instruments established in different parts of the world, on which shocks and tremors can be recorded, there will be more opportunities of finding out whether certain breaks of cable are caused by earthquake, or in some other way. A great many of these breaks, as is well known to telegraph engineers, occur at certain times of the year, which rather points to some such source as submarine springs instead of earthquakes. All these things are complicated.

You will, I am sure, all join with me in thanking Prof. Milne for the most interesting and humorous lecture he has given to-night.

THE PHYSIOGRAPHICAL FEATURES OF THE NYASA AND TANGANYIKA DISTRICTS OF CENTRAL AFRICA.*

By J. E. S. MOORE, A.R.C.S.

The following is a *résumé* of the topographical notes which I collected concerning the character of the country traversed during a recent journey to Lake Tanganyika *viâ* the Zambesi river and Lake Nyasa. The information was gathered in order to obtain the kind of grasp of the physiographical characters of the country surrounding and separating the two great lakes, which would be useful in comprehending the special zoological problems I had in hand. It may be said, at the outset, that there exists a great deal of misconception concerning the physiographical characters, not only of the "far interior," but also of many aspects of the country which lies east and west of the Shire river, and which constitutes the southern three-quarters of the environment of Lake Nyasa. The assumption seems to have been implicitly, if not explicitly, made that this lake, because it is long, narrow, and deep, owes its origin to the formation of the great series of rift-valleys which are such a conspicuous feature of the country further north. But a very little acquaintance with the shores east and west, and of the adjacent country to the south, is sufficient to show that the changes in the level of the land which have enabled Nyasa to stand where it is now, 1500

* Map, p. 348.

feet above the sea, had nothing to do with a rift; in fact, when one has reached the foot of Morumbala, facing the Shire river, a country has been entered which is typical of by far the greater part, not only of the Nyasa districts, but of the region known as the Shire highlands also. Here the country is composed of more or less lofty granitic masses, the axes of which run approximately north and south, but which divaricate from one another and enclose wide areas of land, which are now filled with modern alluvium, and form the extensive malarial flats or dambos which are the chief features of the country to-day. In fact, except for narrow rocky eminences visible in all directions, the whole region is composed of a succession of swampy plains at different levels and of widely different areas, many of which have undoubtedly at one time been covered with water, but are now more or less completely filled up with the decomposed granite and gneiss annually swept down into them from the hills by the prolonged tropical rain.

From the Kirk range and the higher portion of the Angoni country on the west, to the lofty mountains behind Lake Shirwa on the east, the whole country, as one moves northward towards Nyasa, is seen, on examination of different portions of it, to be made up in this simple way of successive modern flats and ancient mountain ranges, entirely composed of gneiss and granite, and this necessarily renders the whole district, geologically speaking, without a history.

On ascending from the great Zambesi and Shire river-beds near Katunga, and passing northward across the mountains through the new Blantyre settlement, one reaches a plain which descends slowly towards the east, and stretches between the Zomba mountains on the north and the still greater heights of Mlanje on the south. The eastern extremity of this plain is occupied by the immense reed swamps and foul open salt water of Lake Shirwa, and it terminates still further to the east in the unknown mountainous districts south of the Lujenda river, which flows east and north towards the northern boundary of the province of Mozambique. The horrible nature of the country round Lake Shirwa is almost indescribable, but every objectionable feature of a tropical quagmire seems to have become accentuated about its dismal, sweltering shores, and the crowds of cranes, flamingoes, and screaming waterbirds, which jostle one another for room among the reeds, only add to the peculiarly depressing nature of the scene. Above the surface of this detestable lake, which is always blurred by a mirage effect (that seems to be related to the miasmatic stench lying over its surface, and which one can escape by standing up in a canoe), there are two conspicuous islands exactly similar in structure to the granite kopjes which rise above the surface of the plain near the lake.

To the north of the Zomba mountains the Shirwa plain bends west and north, and in the latter direction, as Mr. Hetherwick showed some time ago, the surface of the lake is little more than 50 feet below the

top of the watershed, which slopes down the course of the Lugenda river to the east coast. Westward the plain extends round the mountains north of Zomba, and is in reality only separated by a very slightly elevated tract of forest from the wide extent of marsh which skirts the eastern shore of Lake Pamalombe.

Like Shirwa, Pamalombe forms the umbilicus of another great plain, which is bounded on the east by the western face of the Shire highlands, and on the west by the Kirk range and its northern extensions, while it is shut in and terminated towards the south by an elevated ridge, through a gap in which the Shire river finds its way to the lower plains, down the Murchison cataracts. To the north, this plain is really continuous with the great alluvial flat surrounding the southern shores of Lake Nyasa. Thus it will be seen that beyond the southern extremity of Nyasa there exists to-day a series of great alluvial flats which are approximately of the same height, and throughout their entire extent these flats show abundant evidence of having been covered at one time, or a succession of times, with water. There are many places in which the dry mud and sandy clay which form the soil contain the remains of Melanias and Viviparas now living in Shirwa and Nyasa.

Unfortunately, I was not able to make observations on the plain between Lakes Shirwa and Pamalombe, and consequently am ignorant of its height, but if it is not higher than the top of the watershed north of Shirwa, an elevation in the water of Nyasa sufficient to cover this tract would not only connect Shirwa with Nyasa, but would cover a great part of the Mlanje plain, and the whole of the flats east and west of Pamalombe, as well as those about Fort Johnston south of Lake Nyasa. It would, in fact, extend Nyasa enormously to the south; but such an extension is now impossible, owing to the level of the outlet of the Shire river at the Murchison falls being what it is. This outlet, however, is lower than it was once, owing to the erosion and cutting down of the river-bed by the rains. I shall return to this again.

The depression in which Nyasa lies is divided towards the south into two great arms, one of which to the east is, as I have said, geographically continuous with the Mlanji, Shirwa, and Pamalombe plains; while the other terminates more abruptly in the mountains near Manganga's. The lofty neck which separates these two branches of the lake is a rugged continuation of the branch of the Kirk range which faces Pamalombe to the west, and is terminated to the north in the wild mountain headland above the site of the old Livingstonia Mission. Like the high mountain masses which flank the lake east and west, this tongue is composed almost entirely of granite and granitoid rocks, and the lake lies thus, towards its southern extremity, in a series of deep valleys (see Fig. 1), similar in all geological aspects to those encountered in the Shire highlands. There is nothing suggestive of great faults or the formation of rift-valleys, and what is true of the

southern moiety of the lake is also true of the middle and as far as the commencement of the upper third of the lake's extent.

From Rifu, where the two southern arms unite, the mountain ranges which flank the lake east and west gradually increase in height and grandeur until they produce the sublime scenery about Nkata bay. Beyond this, however, there is a sudden change. Voyaging up the lake as I did along the west coast, one becomes aware of a mountain mass projecting beyond the general coast-line, the contour of which is totally

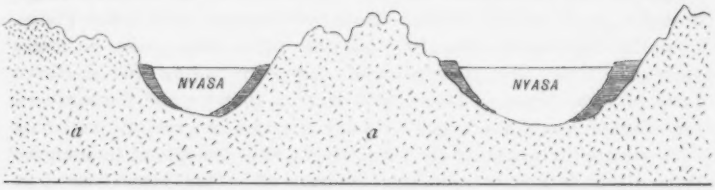


FIG. 1.—SECTION THROUGH THE TWO SOUTHERN ARMS OF NYASA: *a*, *a*, GRANITE AND GNEISS.

unlike that of any previously seen. Here, instead of the jagged profile or massive form of the gneiss and granite mountains, one sees the terraced outline of a lofty stratified scarp, which, on approaching nearer, is seen to be part of a V-shaped mass of stratified rock, sandwiched in between the gneiss and granite ranges on either side. The top of this mass forms the summit of Mount Waller, the surface of which is approximately flat; but the whole of the strata has a slight dip to

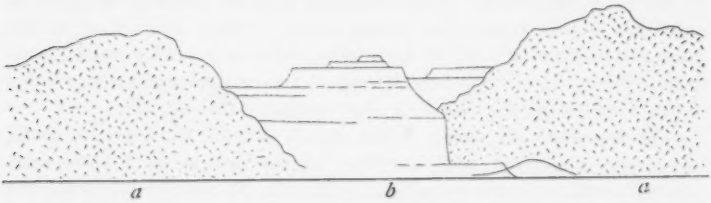


FIG. 2.—THE COAST ROUND MOUNT WALLER: *a*, *a*, GNEISS MOUNTAINS TO THE NORTH AND SOUTH OF THE STRATIFIED MASS OF MOUNT WALLER, SANDSTONES, ETC., IN BETWEEN (*b*).

the west, so that the crest of the scarp is higher than the plain behind it.

On the north and south this mass is bounded by the gneiss and granite mountains, and the stratified material rests in what appears to be its original position between the hills (Fig. 2). The most characteristic feature which this succession of scarps present to a spectator on the lake is a series of massive red sandstone cliffs. These rest upon a conglomerate base, and this in turn is supported upon a mass of granitoid material

and gneiss. The red sandstone, which is about 800 feet thick, is covered by a series of fine yellow sandstones, and is finally topped by a species of shale, and this is probably related to the displaced coal (which has already been described by Stewart *) from a deep gorge in the south. The exposed faces of red sandstone are much contorted in places, especially towards the north, giving one the impression that this twisting has been produced by the upthrusting of the igneous material upon which they rest. The granitoid base upon which the whole series rests is visible in places just above the present water-level of the lake. Here the great stratified cliffs rise to a height 2500 feet above the water's edge, and their northern extension stands equally perpendicular above a low neck of land which stretches out into the lake to the north. This neck is also composed of stratified material, but the surface rocks themselves are here similar to the yellow sandstones and shales of the top crest of the scarp of Mount Waller. Thus we have here, not only the existence for the first time in the Nyasa region of what are clearly aqueous deposits, but also the existence of a gigantic fault producing the series of imposing sandstone cliffs which in this place face the lake to the east. On ascending Mount Waller in company with Lieut. Rhodes, we saw that the stratified mass lying between the higher igneous ranges extended far inland from the lake-shores, seeming, indeed, to pass completely through the bold coast ranges which fringe the lake, and I subsequently came to the same conclusion when viewing this region from a point on the great Nyika plateau 7700 feet above the level of the sea, and between 20 and 30 miles to the north.

Now, on crossing the lake and looking to the east towards Amelia bay, on the opposite coast, it is curious to find the same set of features again repeating themselves—the same stratified masses lying between granitoid ranges, the same faults and scarps; but this time they look the other way. Thus one encounters at this point on Nyasa, for the first time, all the appearance of a double succession of scarps and intervening lower land, or rather lake bottom, characteristic of the so-called rift-valleys further north.

To the north of Mount Waller, the superficial strata on the neck of land which projects out into the lake have the same tilt as the top of Mount Waller, and are composed, as I have said, of the same material as the upper portion of the Mount Waller scarps; and on this neck there are, as Mr. Swann pointed out to me, above the lowlying forest near the lake, some conspicuous white hillocks. These stand some distance back from the lake-shore, and have been freely denuded by rain, etc., into cliffy faces which look in all directions. The white material of which they are composed is a species of limestone, and the strata have the same dip to

* *Proceedings Geo. Soc.*, vol. iii. No. 5, p. 264. See also Drummond's description, 'Tropical Africa,' p. 187.

the west as the yellow sandstones and shales on which they stand. These beds contain fossilized remains of the shells of the molluscs now living in Nyasa, and as their flat tops are some 80 to 100 feet above the water-level, it is pretty clear that they must have been carried upward through the operation of the same great up-push which raised Mount Waller and the adjacent country to its present height. There is every indication here that the formation of the rift has been produced by a crumpling and consequent upthrust of the igneous base (which carries the stratified material) along two parallel lines, one of these being coincident with the hills behind Bandawe and Deep bay, and the other being really a continuation of the great Livingstone range on the other side of the lake. It is, moreover, clear that this elevation must have gone on long after Lake Nyasa had become a lake, as it has thrust up also what were once portions of its deep floor, so that they are now exposed along the flanks of this elevated country as the white masses I have just described; and, lastly, as these beds contain the remains of molluscs identical with those now living in the lake, it is obvious that the faulting which produced Mount Waller must have occurred at what is, geologically speaking, no very remote period of time.

This brings us to a question which was always before me while journeying round Nyasa, as to whether these changes of level of the coasts are still going on, for one of the most marked features of the shores all round the lake are the widely different levels at which the water has stood at different times. The above examples of colossal earth-movements in comparatively recent geological periods lead naturally to the questions, first, whether the apparent changes in the water-level have been, or are in any way connected with such movements; and, lastly, whether such changes in the relative heights of the country are still in progress. It was not, however, until I reached Karonga, some 40 miles north of Deep bay, that I discovered indisputable evidence of localized change of level in the coast-line of the lake. The flat sandy beach of this part of the lake is continued as a great marshy plain, which extends for many miles north, and which has at some time been covered by an extension of the lake itself. This extension of the lake must have reached to, or near, the semicircle of hills which bound the plain on the east, west, and north. Now there are, in almost every part of Nyasa, evidences of at least three successive beaches. The first of these is 4 or 5 feet above the present wet-season water-level; the next some 10 or 12 feet above this, forming a beach which is almost always covered by enormous baobab trees. For the sake of clearness, therefore, I shall speak of this as the baobab beach. Lastly, there are in some places distinct traces of a third shore 30 or 40 feet above the baobab beach. On the sandy flat at the north end of the lake, the baobab beach is naturally not so easy to trace, as the sand and dust of which the plain is

composed has been blown into the low places and partially fills them up, together with the rank tropical vegetation which springs up on such plains whenever there is sufficient moisture for it to live. But there are here in some places traces of the baobab beach having existed 400 or 500 yards back from the present lake-shore.

About half a mile east of Karonga, where the Kambwi river enters the lake, there are some low sand bluffs forming soft cliffs about 10 feet high; and at one point, where they are most conspicuous, I found the sand to be underlain by a mass of clayey material, which contains the remains of an old plain covered by forest trees, the fragmentary remains of which are now quite blackened, and buried in this clay. The clay dips east and west, and, after a couple of hundred feet, is lost at both ends below the water-level of the lake. Thus we have here a forest which must have existed not only before the baobab beach some 20 to 25 feet above it, but before the much higher third water-level. Either, therefore, this forest must have been lowered before these two beaches were formed, or Nyasa must once have stood a great deal lower than it does even at the present day. There is, however, direct evidence of *local* change of level near this place, which is going on at the present time. Not more than 2 miles west of the clay, Dr. Cross took me to a spot where are to be seen, about 50 feet out in the water of the lake, some trees standing in their original positions, the trunks of which are now covered to the height of 5 or 6 feet; and these trees, the natives assured us, were alive and accessible not many seasons back, although the water of Nyasa has been persistently lower on the whole for several successive years. We have, therefore, evidence of two kinds relating to the level of Nyasa—one afforded by old beaches, which are a general feature of the lake, and the other by the existence of elevations and depressions of localized areas. The latter phenomenon exhibits the action of forces which have produced gigantic effects in the past, and which are seen, by the existence of the raised limestone beds near Mount Waller, to have been operating long after Nyasa had become a lake; and they are still in operation near Karonga at the present day. Thus it would appear that the great granitoid mountain cores which form the lateral walls of the Nyasa valley have been accentuated, if not produced, by the same superficial crumpling and upthrust which is apparent in so many parts of the Earth, and that this localized elevation, where stratified material stretches from ridge to ridge, has given rise to the gigantic faults seen about Mount Waller. Further, owing to the parallel nature of this ridging, parallel faults have been produced on opposite sides of the lake, whereby the sandstone beds, resting almost in their original positions on the igneous cores behind them, have been thrust up into the air, and stand now as conspicuous scarps facing one another on opposite sides. I have laid stress on the apparent manner

of formation of this particular strip of rift-valley, because it is not quite the same as that ascribed by Gregory and others to the numerous structures of the same kind further north. There is no evidence, then, zoological, geological, or otherwise, to show that Nyasa is at all of ancient origin; but it is older than the faults among the sandstone beds along its shores, and this is a point of some considerable interest, to which, when speaking of the relation of Nyasa to Tanganyika, I shall immediately return.

It has already been ascertained that the extreme north of Nyasa is bounded by a number of recent though extinct volcanic cones, the former activity of which has produced the floating pumice stone often found about the northern shores of the lake. According to Joseph Thomson's * geological sketch-map, the country which this volcanic material covers is shown as extending far down the Livingstone range to the south. This is not strictly accurate. The

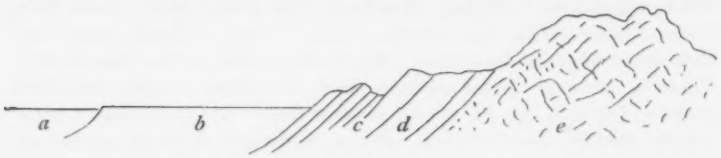


FIG. 3.—SECTION OF COUNTRY FROM KARONGA TO TOP OF PLATEAU, NORTH-WEST: *a*, LAKE; *b*, ALLUVIUM OF LAKE-SHORES; *c*, TRIASSIC BEDS; *d*, SANDSTONES AND CONGLOMERATES; *e*, GRANITE AND GNEISS.

volcanic material extends in reality but a little way beyond the extreme north of the lake, and most, if not all, of the western counter slopes of the Livingstone range show a structure of mixed granitoid and gneiss rocks, similar to those of the country further south.

On leaving Karonga, *en route* for Tanganyika, one passes first over the long alluvial plain which skirts the lake, and then up over some forest-clad hills, which form the outer rampart of the great interior plateau; and it is on these lower spurs of the higher mountains beyond that the Triassic beds described by the late Mr. Henry Drummond † occur. This stratified material lies on the flanks of the higher mountains, in a series of beds with a high dip to the south-east towards the lake, and one consequently passes over their denuded extremities in reversed order, the upper being traversed first (see Fig. 3). These beds, however, are not placed directly on the granitic cores which rise clear of all stratified material further inland, but rest on a great thickness of upturned sandstone (Fig. 3), similar in all respects to the massive beds in the Mount Waller series. These red and yellow sandstones and conglomerates are continued up to the top of the plateau to the height of about 4500 to 5000 feet; but they are here seen to be broken through in all

* 'To the Central African Lakes and Back.' 1881. † 'Tropical Africa.' 1888.

directions, by masses of granitic material, which rise in places to the height of fully 7000 feet. These gneiss and granite masses spread out from one another at this point of entry to the plateau into two lofty ranges, one being continued in a north and the other in a south-westerly direction. The entire space between them is filled by an elevated flat of immense extent, covered with forest, and sloping slightly away to the west. This plain carries the Chambezi river, the headwaters of the Congo, and, as far as I could ascertain, is everywhere composed of the sandstones and conglomerates described above. The average height of this plain is about 4500 feet, and it will be remembered that this is about the height to which the flat top of the Mount Waller district reached in the neighbourhood of Deep bay. The plain is certainly extended to an immense distance west and south, and it is in the highest degree probable that the neck of elevated sandstone formation which crosses the granitic ranges in the locality of Deep bay is continuous with this plain, round the so-called Nyika region, to the west, the lofty northern boundary of which is visible as the Konde mountains from the point I have now reached. If this is so—and I have very little doubt of it myself—it will be seen that the great elevated sandstone plain is really continued through the Mount Waller neck, across the bottom of Lake Nyasa to Amelia bay, and there may be in connection with the similar formations which are known to exist further east towards the coast. Now, this sandstone plain is unbroken in its continuity westward to Tanganyika, but a succession of rugged gneiss and granite mountains break through it in a north-easterly direction all the way. On the other side, that is, on the east of this range, the sandstone formations are again encountered, and Mr. Bell informed me that a few miles east of Fife he saw lofty sandstone escarpments, which suggest a reappearance of the rift about Mount Waller to the north of Lake Nyasa. In fact, travelling from Karonga on Nyasa in the direction of Lake Tanganyika, one is nearly always on the western face of a more or less broken-up range of hills, which gradually pass off the track to the east on nearing the country round the southern end of Tanganyika. While on these hills, which are a continuation of the gneiss and granite cores extending north-west from the Karonga plains, every point of vantage which renders a view to the west over the interminable forests possible, discloses the existence of an equally interminable series of western plains which form the great Awemba country. These plains slope everywhere slightly to the west, and their lowest parts in that direction are filled by the vast swamps and open water of Lake Bangweolo. Beyond this lake the plains are terminated by a broken mountainous country, continuous with the hills flanking the shores of Lake Mwero, and about the nature and structure of which little or nothing is known. This description of the country lying along and west of the route from

Karonga to the south end of Tanganyika will be seen to differ markedly from that given by Joseph Thomson in his journey over what might appear at first sight the same track; but this disagreement arises, in part at least, from Thomson's route having been along the top, if not on the eastern counter-slope, of the broken mountain ranges running north-west, which I have just described. He therefore missed the sandstone plains to the west through the greater part of his route, but I am at a loss to understand how he can have come to the conclusion that schists, gneiss, and clay slates extended over the country north of Mambwe, since passing from this point I found no such formation, but passed almost immediately from granite and gneiss to the typical sandstone plains.

On leaving the mountains to the east at Mpanda, and passing north-west towards Tanganyika, the country is *still* composed of sandstone and conglomerates, but here they are much broken and thrown up and down into a rough forest country, the details of which it is exceedingly difficult to understand. These irregularities soon give place, after passing Fwambo's village, to regular faulting, which extends north-west in the same general direction as the axis of Lake Tanganyika itself, and these faults in the high country are in reality the continuation or tailing out of the great Tanganyika series. Still keeping on the elevated plain, but approaching Tanganyika from the south-west corner above the little village of Mbete, the elevated crests of the great northern range are still occasionally visible further and further away to the north-east, until they seem to terminate that way in a solitary mountain peak. The southern arm of Tanganyika, which lies between these hills and the foot of the plateau at Mbete, is not, however, visible until one stands on the crests of the great sandstone cliffs which rise 2000 feet above its western shore. The sublime views from this and similar points along the western escarpments of the lake can be imagined from the colossal magnitude of the physical features which compose the country around, but they are not repeated on the eastern shore. There the country rises gradually from the water's edge, the shore being covered with the broken fragments of the underlying sandstones, which have here the characters of the upper layers along the western cliffs. The eastern slopes are covered with the usual forest, and rise gradually towards that continuation of the north-west range which I have described. In fact, throughout the whole of the southern portion of the lake the country to the east of it appears, so to speak, to be piled upon this range.

Northwards the lake widens out on its western side, into the great gulf known as Cameron bay, and this gap is in reality caused by one of a series of faults the long axes of which lie at right angles to the axis of the lake as a whole. There is evidence of considerable outpouring of lava at Sumbu, the western extremity of this gulf, and a little to the

south, along the lower course of the Lofu river, there is the best example of a rift-valley which I have seen. This valley is simply the exact inverse of what is known as a block mountain, and consists of an oval mass of land, some 35 miles long and 8 to 10 miles broad, which has bodily sunk, so as to leave an enclosing fringe of lofty sandstone cliffs all round. North of this district my observations differ from those of Thomson in a marked degree. In Thomson's geological map the whole of the point marked Kassava in mine is indicated as composed of felspathic rocks. I have travelled over this region twice by land, and been round its shores several times by water, and I can affirm that it is certainly composed, apparently entirely, of the sandstones and conglomerates which compose the adjacent hills. Further, the tract of country covered by the route from Kassava point to Sumbu is also included by Thomson as being within his felspathic area; but I have examples of rocks gathered in this very place, which are indistinguishable from the sandstones and conglomerates in the cliffs above Mbete. There is a species of ironstone here which is not found at Mbete, but otherwise the series appear to be identical. Further, the point of land between Sumbu and Teleka's village is also composed of the sandstone series; and, again, the great cliffs on the northern shore of Cameron bay as far as Pamlelo's repeat the same story. Thomson must therefore have fallen into some error over this, or have confused these districts with something which he observed further north. Anyway, it is quite clear that the southern part of what he calls the felspathic area is not at the place where he supposed it to be. The map of this author also represents that part of the east coast of Tanganyika which lies between the Kilambo and Kawa (?) rivers as being composed of gneiss and slate. The shores of this region, however, appear to be composed of sandstones of different varieties, comparable to the upper series of the western coast. The reason of this difference, however, is not so difficult to see, because Thomson left the coast at this point, and journeyed inland and up, thereby coming upon the geological formations characteristic of the mountains inland from the coast; continuing inland, he seems to have come across metamorphic rocks beyond the Kawa (?) river, and to have jumped to the conclusion that these were also present on the lake-coast. This, however, does not appear to be the case, metamorphic rocks not being encountered for many miles north of this point along the shore.

Thus it will be seen that the southern half of Tanganyika lies at the bottom of a succession of great faults in a series of massive sandstones and conglomerates, which seem to extend in unbroken continuity through the great elevated plain of the Awemba country, as far as Nyasa and Angoni land to the south. These massive stratified formations extend thus over a vast area of the African interior; they extend east as well as west along Nyasa, and are

connected together across the Nyasa valley, first by the narrow neck in the region of Mount Waller, and, secondly, beyond the lake to the north. The whole of the high interior plateau, which extends in unbroken continuity far up the coasts of Tanganyika, and is encountered again round the southern shores of Lake Rukwa to the east, stands nearly everywhere about the same average height above the sea. Thus the top of Mount Waller is about 4000 feet; the great sandstone plain west of Mweinwanda's is the same. Lake Bangweolo, which fills the southern portion of this plain, and which is not more than 10 or 12 feet deep, stands between 3000 and 4000 feet. The great plains west of Tanganyika fall to the west from 4500 to 3500 feet. But this vast area of sandstone is pierced in all directions by high upstanding masses of gneiss and granite rocks, which rise as mountain chains above the general level of the sandstone plains, like islands above an ancient sea, and as the sandstone formations rest approximately in their natural positions upon these upthrust igneous rocks, it is by no means impossible that this is what they really are.

Unlike Nyasa, Tanganyika lies wholly in a series of valleys formed by faults running north and south along the interior plateau, and it is obvious that this lake may be as old, but it cannot be older, than the date of formation of the valleys at the bottom of which it now exists. Nyasa, on the other hand, was evidently in existence as a lake (as is evidenced by the limestone beds near Deep bay, which I have described) at a time when similar faulting was going on. But as the fossils in the beds about its shores are similar to the animals now living in the lake, it is obvious that the time of their upheaval cannot have been, geologically speaking, very long ago. There is no geological evidence, that I am aware of, from which any notion of the date of the formation of the Tanganyika faults can be formed, but, according to Gregory, similar rifting has been of comparatively recent date further north. The geological evidence concerning the date of origin of these lakes and their ages relative to each other, therefore, cannot be pushed to any definite conclusion; but there is, on the whole, a certain amount of evidence that Nyasa, as a lake, is the older of the two! I would draw attention to this point, because it has a most important bearing on the zoological problems with which I have been primarily concerned.

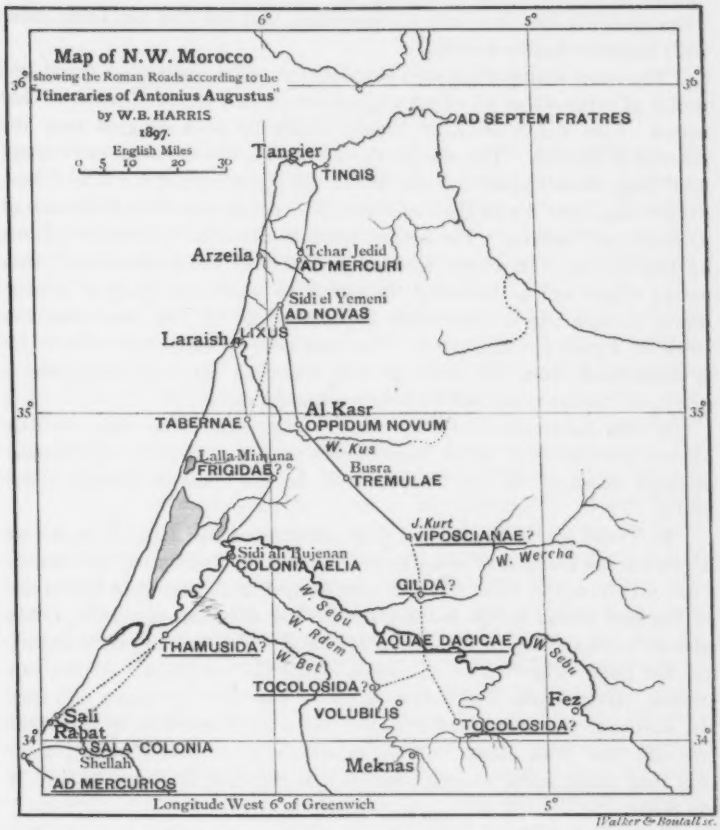
THE ROMAN ROADS OF MOROCCO.

By WALTER B. HARRIS.

THE "road-book," or "Itineraries," of Antoninus Augustus have left us sufficient information to gather some tolerably correct idea of the positions of the towns, etc., that existed at stated intervals along the two main Roman roads of Northern Morocco, for it must be remembered that there

is no evidence to prove that the Romans ever penetrated much to the south of the site of the present city of Meknas (Mequinez).

In the accompanying map the writer shows, as far as present information goes, the sites of the towns and the direction of the roads. Some of the spots were identified by M. Tissot, and the explorations at Volubilis by M. de la Martinière have thrown considerable light upon



the question. In spite of more than one journey to attempt to discover some trace of the sites marked as doubtful upon the accompanying map, the writer has failed to find any satisfactory remains of Roman ruins at or near the spots where one would naturally look for them.

Frigidæ seems to have been a collection of small towns or villages, of which ruins still exist. When in 1896 the writer was travelling in this district, he found natives busily engaged in excavating what certainly

must have been Roman pipes, some 5 inches in diameter, which apparently carried water from a spring on the hillside to a town or village in the plain. It is not impossible that this very water gave the name to the settlement (Frigidæ). Tissot mentions that the spot is still called "Ma Berd" ("cold water"), but the spring to which is applied this name—a very common one in Morocco—is some miles distant, and as "Ma Berd" is constantly cropping up all over North Morocco, it is more than probable that it is only a coincidence, and not that the Latin name still exists to-day in Arabic.

The exact site of *Tocolosida* is unknown. The writer has found two series of ruins either of which might have formed the settlement of that name. Like Volubilis (Kasr Faraun), they are both situated near the district of Zarhun. The one group of remains, the foundations of many buildings of well-squared stone, lies on the right bank of the Wad Rdem, where that river forms the boundaries between the existing tribelands of Geruan and Zarhun. The second possible site is on the summit of one of the Zarhun hills, at the eastern extremity of the mountains of that name, where are to be found the complete walls and gates of a large town, though the workmanship appears to be of later date than the time of Antoninus Augustus. The best mode to reach the ruins is by a sheep-track from the Zauia of Sidi Abdullah ben Aziz, from which they are distant some half an hour's steep climb.

If this latter should be the site of Tocolosida, then there is little reason to doubt that Aquæ Dacicæ was near one of the many sulphur springs existing on the slopes and in the valleys beneath Jibel Silfet.

M. Tissot places Viposcianæ near the present Sôk Jibel Kurt, where there are the remains of some walls standing, and, accepting this theory (not only from the ruins, but also because even to-day the spot lies on one of the best routes in the country for fording the various rivers), Gilda should be looked for on the banks of the Wergha, the largest tributary of the Sebu, some 12 or 15 miles above the confluence of the two rivers. Here again the writer failed to discover any signs of ruins. If, however, the former of the two sites of Tocolosida is the right one (on the Wad Rdem, a few miles south of Sidi Cassim), then the road must make a more easterly *détour* thence, if Aquæ Dacicæ is on Silfet.

Tremulæ is without doubt Busra. Before the writer ever saw the "Itineraries," or heard the name of the Roman stations, he was taken to Busra by the natives to hear a curious underground rumbling sound, as if of a subterranean river. He certainly failed to hear it, but the inhabitants of the neighbouring villages all hear it from time to time, though they asserted that it was not only apparent in the rainy seasons, but came at regular periods. This may well be doubted. It seems much more probable that there exists some subterranean cavern in the

hills near by, which at times finds an outlet for its overflow of water by an underground channel, or possibly a Roman aqueduct.

The other sites are all tolerably certainly identified, and in most of them various degrees of ruins can be seen, though nowhere much more than the remains of buttressed walls, and often only traces of foundations.

RECENT RESEARCHES ON CLIMATE.

By H. N. DICKSON.

THERE has been, within the past few years, a marked tendency to change in the methods of investigation most in favour amongst meteorologists. The fatal blow dealt by Hann to Ferrel's theory of cyclones induced a certain amount of reaction against strictly mathematical methods, and it was not until the general recognition of von Bezold's striking series of papers on the true behaviour of air and vapour in the atmosphere that a fresh start was made, and a new line taken in dealing with the vast masses of observational data continually accumulating. It has become apparent that, however valuable from a purely scientific point of view a rigorous investigation of atmospheric movements may be, the endless irregularities in the distribution of land and sea, in the composition, exposure, and covering of the land surfaces, and in the thermal arrangements at and below the sea surfaces, give rise to abnormalities of such magnitude as to deprive purely mathematical results of much of their practical value. Again, as in space distribution so in time variation, the long-period average, while it rids us of temporary aberrations, also in many cases deceives us as to the real march of events, and we confound frequency with efficiency in comparing effects with what we suppose to be their cause. Finally, we must avoid the other extreme, and not limit ourselves to instants of time and points of space; the eddies and ripples on the atmospheric streams move slowly enough for us to watch their motion, but they are still of the nature of eddies and ripples, and as such must always be uncertain and indefinite; in other words, we cannot look for very much more help than we have already got from the synoptic weather chart.

The most hopeful line of inquiry, one to which a daily increasing number of meteorologists are directing their attention, may be briefly described as consisting of a closer study of the great atmospheric areas of cyclonic and anticyclonic circulation, and of the transitional regions lying between them. We have, for example, such systems as the Atlantic anticyclone, the great Eurasian system extending from Germany to China, and the so-called Greenland depression: the

monumental labours of Buchan and Hann have clearly defined the average limits and intensities of these systems at different seasons in so far as this is possible by mean isobaric lines, but we as yet know little in detail as to the changes of relations taking place amongst them from one month to another in any single year, and less as to the causes which produce these changes. It seems more and more evident, however, that a study of the successive variations occurring within these immense, and, be it added, somewhat sluggish systems, and on the surfaces upon which they lie, will tell us enough about them to allow of their variations being predicted, and such prediction, although it would not help in detailed short-period forecasting for small districts, would afford a method of general long-period forecasting which might prove of the greatest economic value.

In this connection, it may be worth while once more to point out the immense simplification which might be introduced in the elementary parts of physiographical teaching by the popular recognition of these great atmospheric systems. The prevailing winds and ocean currents are a formidable tax on the student's memory when each, as still usually happens, has to be learned separately, but the natural grouping of trade winds, westerly variables, belts of calms, drift currents, etc., round these systems is at once simpler, more accurate, and more scientific.

It is difficult, without going further into mathematical technicalities than is admissible here, to give a satisfactory outline of the chief papers to which we owe the great promise of progress. The preliminary papers of Dr. W. Zenker, of Berlin, have been noticed in the *Journal* from time to time, and his methods and results are amplified and extended in the exhaustive memoir on "Der thermische Aufbau der Klimate aus den Wärmewirkungen der Sonnenstrahlung und des Erdinnern," * recently published. The first part of this memoir is devoted to a development of methods, and attempts to account for the estimated quantities of heat received from the sun at different parts of the Earth's surface (*i.e.* in different latitudes) at different seasons. The "condition of continuity" being that as much heat is given off as is received, since the atmosphere does not become permanently hotter or colder, a careful examination is made of the heat-changes taking place under typical "oceanic" and "continental" conditions. The purely oceanic conditions are the most difficult to realize, since the isothermals drawn over the oceans are still to some extent hypothetical, but such a station as Yakutsk is almost wholly free from any but continental influences. One of the most interesting comparative results is that in a typical continental climate the sun-effect shows itself completely on the temperature of the atmosphere after an interval of

* 'Nova Acta Academiæ Cæsareæ Leopoldino-Carolinæ Germanicæ Naturæ Curiosorum,' tomus lxvii.

twenty-four days, while in a typical oceanic climate the interval is thirty-nine days, *e.g.* the maximum air temperature occurs twenty-four and thirty-nine days respectively after the sun reaches its highest point. This result may be taken as an example of several elements which lead in various ways to a quantitative estimation of the relation between continental and oceanic influences in the climate of any given region. The second part of Dr. Zenker's memoir consists of an application of his methods to the great climatic regions of the globe, and it offers many interesting opportunities of tracing the extension of land influences over the oceans and of ocean influences over the land. The weak point in the investigation, which as a whole must be accepted as an important contribution to knowledge, is the weight necessarily given to estimations of the humidity of the atmosphere. The observations of this factor, especially at sea, are still lamentably defective, and none of the instruments at present available seem to give really trustworthy results. The cloud observations which find a place in Dr. Zenker's work are also open to a good deal of criticism.

Working on somewhat similar lines, but by different methods, Dr. H. H. Hildebrandsson, director of the Meteorological Observatory at Upsala, has recently communicated to the Swedish Academy of Sciences a memoir on "Centres of Atmospheric Activity." A discussion of the variations of pressure in the great atmospheric systems discloses the existence of certain oscillatory movements, which, when we know more about them, may afford a direct path towards forecasting in the mode we have already hinted at.

The work of Prof. Pettersson, of Stockholm, in the same direction has already been noticed in the *Journal*. It stands, as it were, intermediate between the investigations of Zenker and Hildebrandsson, and brings into strong relief the importance for all climatological investigations of a further study of the surface changes taking place at sea. When we clearly understand the precise physical relations existing between the surface waters of the ocean and the air resting upon them, it seems likely that the logs of a few liners will supply all the information required to frame a forecast of a cold or wet winter, a hot or cloudy summer.

Turning to recent accessions in the way of observational material, one of the most important is the series of current charts of the North Atlantic recently issued by the Meteorological Office. These confirm, amongst other things, the evidence obtained by other methods as to the feebleness and irregularity of the drift currents in the North Atlantic, formerly ascribed to the influence of the "Gulf Stream." In connection with the meteorology of this region, we may mention a paper of interest read before the Royal Meteorological Society on the rainfall of Dominica, by Mr. C. V. Bellamy, the map showing very prettily the effect of a land elevation lying across the path of a steady wind from seaward.

The collection of sunshine records progresses steadily, although there is still much uncertainty about the merits of various forms of sunshine recorders. Probably, the observations of sunshine are still more complete in the British Isles than in any other country, but Herr Helmuth König, of Hamburg, has found sufficient material for a first attempt to draw 'isohelic' lines for Western Europe. The present writer attained some measure of success in drawing such lines for the British Isles from the ten years' observations published by the Meteorological Office, but, until a more uniform system of recording is generally adopted, it seems hardly worth while to subject the data to rigorous discussion. Herr König's sunshine map is nevertheless extremely suggestive in many ways. An interesting addition to sunshine statistics appeared in *Symon's Meteorological Magazine* for March last, in the shape of three years' records for Kimberley, South Africa. The average recorded during 1894–95–96 was 3260 hours, being, according to Mr. W. Ellis, 74 per cent. of the possible.

A short paper recently issued as a supplement to Bulletin No. 10 of the *Société Khédiviale de Géographie* gives some new information about the climate of Alexandria, as compared with that of Cairo. Its author, Prof. Eugène Franceschi, might perhaps have done well to say less about Cairo and more about Alexandria, but he at least provides additional data for the discussion of the meteorology of the extremely interesting region which lies between Asia and Africa. The publications of the Meteorological Office referring to the Red Sea, and of the Palestine Exploration Fund, might now perhaps be combined with such papers in a more detailed examination of the complex transitional phases observed in this region during, for example, the months of September and October, than has hitherto been attempted.

Lastly, attention should be drawn to some studies of temperature changes, evaporation, and condensation on different species of land surfaces, notably an extremely able one by Herr P. A. Müller, "Ueber die Temperatur und Verdunstung der Schneeoberfläche und die Feuchtigkeit in Ihrer Nähe," published as a continuation of previous work, in the *Memoirs* of the Imperial Academy of Sciences of St. Petersburg. We have already touched upon the value of detailed study of the relations of water surfaces to the strata of air resting upon them, but the importance of similar work under the more variable land conditions cannot be overestimated, and we commend the investigation of questions of exposure of different surfaces of soil and vegetation at varying slopes and in different directions to the attention of inquirers in this country, where as yet little or nothing has been done.

THE VOLCANOES OF THE BRITISH ISLANDS.*

This large and handsome book contains the personal work of the Director of the Geological Survey, extending over a great number of years. In the intervals of routine duties he has inspected practically all the volcanic rocks of the country, and made himself master of the extensive literature relating to them. Sir Archibald Geikie gives first an outline of volcanic phenomena in general, to serve as an introduction to the special descriptions of the rocks of different ages. He treats the subject from the geological point of view, but with constant reference to the effect of geological structure on geographical form. For the purpose of a study of volcanic phenomena, he shows that no better situation than the British Islands can be found, although the latest volcanoes have been extinct for millions of years, and their surface forms have vanished. This is due to the wide range of geological formations, their great distortion and erosion, which exhibit sections of volcanic rocks formed deep below the surface, and to the remarkably detailed geological mapping of the country. The situation of Great Britain on the transitional area between ocean and continent is also favourable for the manifestation of volcanic phenomena. These he proceeds to trace for each of the great geological periods, the Pre-Cambrian, Cambrian, Silurian, Old Red Sandstone, Carboniferous, Permian, and Tertiary. The remarkable fact is brought out, that while all the rock-systems of the Primary were laid down during periods of marked vulcanism—more particularly the Old Red Sandstone and Carboniferous—the whole Secondary period seems to have been free from any disturbance of the kind, while in Tertiary times the manifestations reappear on a larger scale than ever before.

The volcanic elements of British scenery are due almost always to denudation removing the softer strata and leaving the hard volcanic rocks projecting in bold forms. The rocks themselves are either cooled from a molten state (in a general sense lava or trap), or accumulations of volcanic ashes. The latter make up the greater part of the English lake district, and of such hill ranges as the Pentlands, Ochils, and Sidlaws. The cooled molten rock has either been poured out as lava on the sea-bed or on land surfaces, forming sheets or plateaux, like the great plateau isolated fragments of which appear in Antrim, the Hebrides, the Faëroes, and Iceland, or else as dykes injected through earlier rocks as intrusive sheets or sills, like the Great Whin Sill of the north of England, or the sills which form the line of Salisbury crags at Edinburgh and the terraces of Little Cumbrae island, or as bosses or laccolites which give rise to not a few modern hills, or finally as

* 'The Ancient Volcanoes of Great Britain.' By Sir Archibald Geikie, F.R.S. With seven maps and numerous illustrations. 2 vols. London: Macmillan & Co., Ltd. 1897.

"necks," the solidified plug of lava which sealed some old vent, and now plays the *rôle*, it may be, of a castle site or the nucleus of a town.

The conclusions arrived at are summarized by the author, and we give a concise statement of them—

The region lies along the edge of the North Atlantic ocean, a typically volcanic tract, and the British volcanic rocks stretch over a district ranged from north to south, but only on the western side. East of a line drawn from Berwick by Leicester to Exeter, although there are abundant exposures of all rocks from the Carboniferous to the Pleistocene, there is no trace of volcanic action. Part of this tract in the west was recurrently the scene of volcanic action along the whole range of time, while other regions are conspicuously free from any trace of such effects. At all times the orifices of the volcanoes seem to have been opened along the lines of low valleys, and not on ridges. The volcanic effects are not results of mere local action, but are directly related to the great cosmical processes of the entire globe, and high volcanic activity seems to have been generally associated with a downward movement of the crust. In all geological ages volcanic effects have been similar, falling into a few general types, but the degree of intensity has varied, and at times all activity has ceased for long periods. The exposures in Great Britain allow the whole history of a volcanic period to be studied from beginning to end by means of the differing character of the erupted material, which varies in homogeneity and in chemical composition at different stages, *e.g.* the earlier eruptions of each period were more acid, the later more basic lavas, but in the interval between consecutive periods the magma had been restored to its earlier condition, from which it gradually varied as the period proceeded.

The book is effectively illustrated by reproductions of photographs of the author's sketches and diagrams, and by a series of admirable geological maps.

SOME GEOGRAPHICAL PROBLEMS.*

By J. SCOTT KELTIE, LL.D., Sec. R.G.S.

We meet this year in exceptional circumstances. Thirteen years ago the British Association met for the first time in a portion of the Empire beyond the limits of the British Islands. During these thirteen years much has happened of the greatest interest to geographers, and if I attempted to review the progress which has been made during these years—progress in the exploration of the globe, progress in geographical research, progress in geographical education—I could not hope to do it to any purpose in the short time during which it would be right for a president to monopolize the attention of the Section. But we have, at the same time, reached

* Presidential Address to Section E, at the Toronto Meeting of the British Association, August, 1897.

another stage in our history which naturally leads us to take stock of our progress in the past. We have all of us been celebrating the sixtieth year of the glorious reign of the Sovereign, of whose vast dominions Canada and the United Kingdom form integral parts. The progress made during that period in our own department of science has been immense; it would take volumes to tell what has been done for the exploration of the globe. The great continent of Africa has practically been discovered, for sixty years ago almost all but its rim was a blank. In 1837 enormous areas in North America were unexplored, and much of the interior of South America was unknown. In all parts of Asia vast additions have been made to our knowledge; the maps of the interior of that continent were, sixty years ago, of the most diagrammatic character. The Australian interior was nearly as great a blank as that of Africa; New Zealand had not even been annexed. Need I remind you of the great progress which has been made during the period both in the north and south polar areas, culminating in the magnificent achievement of Dr. Nansen? It was just sixty years ago that the great antarctic expedition under Sir James Ross was being organized; since that, alas! little or nothing has been done to follow up his work. Sixty years ago the science of oceanography, even the term, did not exist; it is the creation of the Victorian era, and may be said almost to have had its origin in the voyage of the *Challenger*, which added a new domain to our science and opened up inexhaustible fields of research. I have thought, then, that the most useful and most manageable thing to do on the present occasion will be to indicate briefly what, in my estimation, are some of the problems which geography has to attack in the future, only taking such glances at the past as will enable us to do this intelligibly.

It has been customary for the occupants of this chair to try to define the field of geography, and on occasions, in somewhat too apologetic language, to justify its existence as a section of a scientific association. I do not think this is any longer necessary. Even in England and America, during the last thirteen years, geography has done work enough to prove that she has a mission which no other department of research can fulfil. I say thirteen years, because that not only carries us back to the last Canadian meeting of the British Association, but to the year when the Royal Geographical Society undertook an inquiry into the position of geography at home and abroad, mainly with a view to the improvement of geographical education in England. During that time a good deal has been written as to the field and scope of geography, and a good many definitions given. But we really did not require to go to Germany to teach us as to the field and functions of geography. Sixty years ago, the then President of the Royal Geographical Society, Mr. William R. Hamilton, delivered the first presidential address ever given at that Society, and his conception of the field and aims of geography was as exalted and comprehensive as the most exacting German geographer could wish. It is too long to quote here.*

It would be difficult to improve upon Mr. Hamilton's definition, and it shows that a correct conception of the wide and important field of geography is no new thing in England. He proceeded to indicate what remained to be done in the field of exploration, and I commend his address to any one desirous of forming a conception of the vast progress that has been made since it was delivered, sixty years ago. Since I am dealing with definitions, I may be permitted to quote that given by one so severely scientific as General Sir R. Strachey in a course of lectures which he gave at the University of Cambridge in 1888, in connection with the establishment of a lectureship in Geography in that university. "The aim of geographical

* *Journal R.G.S.*, vol. viii. 1838.

science," he says, "is to investigate and delineate the various features of the Earth; to study the distribution of land and sea, the configuration and relief of the surface, position on the globe, and so forth, facts which determine the existing condition of various parts of the Earth, or which indicate former conditions; and to ascertain the relations that exist between these features and all that is observed on the Earth. . . . I claim for geography," Sir R. Strachey says, "a place among the natural sciences as supplying the needful medium through which to obtain a connected and consistent conception of the Earth and what is on it." He gives a list of the various matters which, in his conception, it is the business of geography to deal with, and they are varied and important enough to satisfy the demands of the most exacting. "These are," he says, "the studies through which scientific geography will lead you, teaching you to view the Earth in its entirety, bringing together the great variety of objects seen upon it, investigating their connection, and exploring their causes; and so combining and harmonizing the lessons of all the sciences which supply the key to the secrets of Nature." *

I think we may briefly define geography as the science of the topographical distribution of the great features of the Earth's surface and of all that it sustains—mineral, vegetable, and animal, including man himself. In fact, man is the ultimate term in the geographical problem, the final object of which is to investigate the correlation between humanity and its geographical environment.

I may be pardoned for dwelling at some length on the function and field of geography. It is a subject that has been occupying the attention of geographers in England for some years, and it may not be without interest to our colleagues on this side of the Atlantic to know the conclusions which we have come to. Moreover, it seems necessary to arrive at some clear conception on the matter, with a view to the researches of the future. I say that the subject has been occupying our attention in England for some time; it has done so, I may say, as a result of the inquiry by myself on behalf of the Royal Geographical Society to which I have referred. The object of that inquiry was mainly to collect information as to the position of geography in education at home and abroad. The report which I presented to the Society attracted some attention, and whether as a result of that or not it is hardly for me to say, but certainly since that inquiry some twelve years ago the position of geography in England has considerably improved both in education and as a field for research. Better methods have been introduced in our schools; a much wider scope has been given to the subject; in many quarters teachers have shown themselves anxious to be guided in the right direction; and, above all, both Oxford and Cambridge at length consented to the establishment of lectureships in geography. A school of young geographers has grown up, consisting of men who have had a thorough university training in science and letters, and who are devoting themselves to the various branches of geography as a speciality. In this way the arid old text-books and characterless maps are being supplanted by others that will bear comparison with the best productions of Germany. Photography and lantern slides illustrating special geographical features are coming into use in schools; and in other directions appliances for use in education are being multiplied and improved. A British geographical literature is growing up, and if, as I hope, the progress be maintained, we shall be able to hold our own in geography with any country. The interest in the subject has been extended by the foundation of geographical societies in various large centres; whereas thirteen years ago the only geographical society was that of London, there are now similar societies in

* 'Lectures on Geography delivered before the University of Cambridge.' London: 1888

Manchester, Newcastle, Liverpool, and Edinburgh, the last with branches in Glasgow, Dundee, and Aberdeen. If this progressive movement is maintained, as there is every reason to hope it will be, the scientific and educational aspects of geography in Britain will be more nearly on a par with exploration in which our country has so long held the lead.

In the United States I found that the position of the subject in education was not much more satisfactory than it was in England. Since then there is reason to believe considerable progress has been made. One of the best text-books on physical geography, Hinman's 'Eclectic Physical Geography,' is of American origin; while in the States, as in England, a school of scientific geographers has arisen which bids fair to give the subject a high place in that country. I fear, from what I can learn, that the position in Canada is not as satisfactory as it ought to be. It seems to me, then, that one of the great problems which geographers have to face in the future, is the place which this subject is to hold in education—both as a body of information and as a discipline. We have been making progress, and if we persevere with intelligence and firmness, and maintain the subject at the highest standard as a field of research, there can be little doubt of our success.

There is a prevalent belief that geographers have nothing more to learn in Europe—that that old continent has been thoroughly explored. It is true that nearly every country in Europe has been, or is being, trigonometrically surveyed. Except some parts of the Balkan peninsula and North of Russia, the topography of the continent has been accurately mapped on scales and by methods sufficient, at least, for the purposes of the geographer. Yet there are districts in the Balkan peninsula—for example, Albania—which are as vaguely known as Central Africa. But it is a delusion to think that, because a country has been fully mapped, the occupation of the geographer is gone. It is only when a region at large is adequately mapped that the work of geographical research begins. The student, with a satisfactory map of a definite district as his guide, will find on the spot abundant occupation in working out its geographical details, the changes which have taken place in its topography, and the bearing of its varied features upon its history, its inhabitants, its industries. This kind of work has been in progress in Germany for over ten years, under the auspices of the Central Commission for the Scientific Geography (Landeskunde) of Germany, with its seat at Stuttgart. Under the collective title of 'Forschungen zur Deutschen Landes- und Volkskunde,' a long series of monographs by specialists has been published, dealing in minute detail with one or more aspects of a limited district. Thus we have such memoirs as 'The Plain of the Upper Rhine and its Neighbouring Mountains,' by Dr. Richard Lepsius; 'The Towns of the North German Plain in relation to the Configuration of the Ground,' by Dr. Hahn; 'The Munich Basin: a Contribution to the Physical Geography of Southern Bavaria,' by C. Gruber; 'The Mecklenburg Ridges and their Relation to the Ice Age,' by Dr. E. Geinitz; 'The Influence of the Mountains on the Climate of Central Germany,' by R. Assmann; 'The Distribution and Origin of the Germans in Silesia,' by Dr. K. Weinhold; 'Mountain Structure and Surface Configuration of Saxon Switzerland,' by Dr. A. Hettner; 'The Erzgebirge: an Orometric-Anthropogeographical Study,' by Dr. J. Burgkhardt; 'The Thuringian Forest and its Surroundings,' by Dr. H. Pröscholdt, and so forth. There is thus an inexhaustible field for scientific geography in its most comprehensive sense—a series of problems which may take generations to work out. In a less systematic way we have similar monographs by French geographers. One or two attempts, mainly by teachers, have been made in England to do similar work, but the impression generally produced is that the authors have not

been well equipped for the task. I am glad to say that in England the Royal Geographical Society has initiated a movement for working out in a systematic fashion what one may call the regional geography of the British Islands, on the basis of the one-inch maps of the Ordnance Survey. It is a strange thing that the geography of the mother country has never yet been systematically worked out.

Taking the sheets of the Ordnance Survey map as a basis, it is proposed that each district should be thoroughly investigated, and a complete memoir of moderate dimensions systematically compiled to accompany the sheet, in the same way that each sheet of the Geological Survey map has its printed text. It is a stupendous undertaking that would involve many years' work, and the results of which when complete would fill many volumes. But it is worth doing; it would furnish the material for an exact and trustworthy account of the geography of Britain on any scale, and would be invaluable to the historian, as well as to others dealing with subjects having any relation to the past and present geography of the land. The librarian of the Society, Dr. H. R. Mill, has begun operations on a limited area in Sussex. When he has completed this initial memoir, it will be for the Society to decide whether it can continue the enterprise, or whether it will succeed in persuading the Government to take the matter up. I refer to work of this kind mainly to indicate what, in my conception, are some of the problems of the future which geography has to face, even in fully surveyed countries. Even were the enterprise referred to carried out, there would be room enough for special researches in particular districts.

But while there is an inexhaustible field in the future for geographical work in the direction I have indicated, there is no doubt that much still remains to be done in the way of exploring the unknown, or little known, regions of the globe. Let us briefly refer to the problems remaining to be solved in this direction. Turning to the continent of Asia, we find that immense progress has been made during the past sixty years. In the presidential address given sixty years ago, already referred to, Mr. Hamilton says of Asia, "We have only a very general knowledge of the geographical character of the Burman, Chinese, and Japan empires; the innumerable islands of the latter are still, except occasionally, inaccessible to European navigators. Geographers hardly venture on the most loose description of Tibet, Mongolia, or Chinese Tartary, Siam, and Cochin China." Since then the survey of India, one of the greatest enterprises undertaken by any state, has been completed, and is being rapidly extended over Burma. But I need not remind you in detail of the vast changes that have taken place in Asia during these years, and the immense additions that have been made to our knowledge of its geography. Exploring activity in Asia is not likely to cease, though it is not to be expected that its inhospitable centre will ever be so carefully mapped as have been the mountains of Switzerland.

The most important desiderata, so far as pioneer exploration in Asia is concerned, may be said to be confined to two regions.* In Southern and Central Arabia there are tracts which are entirely unexplored. It is probable that this unexplored region is in the main a sandy desert. At the same time it is, in the south at least, fringed by a border of mountains whose slopes are capable of rich cultivation, and whose summits the late Mr. Theodore Bent found, on his last and fatal journey, to be covered with snow. In exploration, as in other directions, it is the unexpected that happens; and if any traveller cared to face the difficulties—physical, political, and religious—which might be met with in Southern and Central Arabia, he might be able to tell the world a surprising story.

* For part of what follows with reference to Asia, I am indebted to a valuable memorandum on the subject drawn up by the late Mr. Ney Elias.

The other region in Asia where real pioneer work still remains to be done is Tibet and the mountainous districts bordering it on the north and east. Lines of exploration have in recent years been run across Tibet by Russian explorers like Prjevalsky, by Rockhill, Prince Henry of Orleans and Bonvalot, by Bower, Littledale, Wellby, and Malcolm. From the results obtained by these explorers we have formed a fair idea of this, the most extensive, the highest, and the most inhospitable plateau in the world. A few more lines run in well-selected directions would probably supply geography with nearly all she wants to learn about such a region, though more minute exploration would probably furnish interesting details as to its geological history.

The region lying to the north of the Himalayan range and to the south of the parallel of Lhasa is almost a blank on the map, and there is ample room here for the enterprising pioneer. The forbidden city of Lhasa is at present the goal of several adventurers, though as a matter of fact we cannot have much to learn in addition to what has been revealed in the interesting narrative of the native Indian traveller, Chandra Das. The magnificent mountain region on the north and east of Tibet furnishes a splendid field for the enterprising explorer. Mrs. Bishop recently approached it from the east, through Sze-chuen, and her description of the romantic scenery and the interesting non-Mongolian inhabitants leaves us with a strong desire to learn more. On the south-east of Tibet is the remarkable mountainous region, consisting of a series of lofty parallel chains, through which run the upper waters of the Yangtse, the Mekong, the Salwin, and the Irawady. This last-named river, recent exploration has shown, probably does not reach far into the range. But it will be seen by a glance at a map that the upper waters of the other rivers are carried far into the heart of the mountains. But these upper river courses are in great measure conjectural, and have given rise to much controversy. There is plenty of work here for the explorer, though the difficulties, physical and political, are great.

But besides these great unexplored regions, there are many blanks to be filled up in other parts of Asia, and regions which, though known in a general way, would well repay careful examination. There is the mountain tract between the upper Zarafshan river and the middle course of the Surkhab tributary of the Oxus, and the country lying between that and the Oxus. There is the great Takla-Makan desert in Chinese or Eastern Turkistan, part of which has recently been explored by Russian expeditions and by that young and indefatigable Swedish traveller, Dr. Sven Hedin. It is now one of the most forbidding deserts to be found anywhere, but it deserves careful examination, as there are evidences of its once having been inhabited, and that at no very remote period. It is almost surrounded by the Tarim, and on its eastern edge lies Lob-nor, the remarkable changes in which have been the subject of recent investigation. As readers of Dr. Nansen's 'Voyage of the Fram' will remember, the Siberian coast is most imperfectly mapped; of course, it is a difficult task, but it is one to which the Russian government ought to be equal. China has on paper the appearance of being fairly well mapped; but as a matter of fact our knowledge of its mountain ranges and of its great river courses is to a large extent extremely vague. All this awaits careful survey. In North-Eastern Manchuria and in many parts of Mongolia there are still blanks to be filled up and mountain and river systems to be surveyed. In the Malay peninsula and in the great array of islands in the east and south-east of Asia—Sumatra, Borneo, the Philippines—much work still remains to be done. Thus for the coming century there will be abundance of work for explorers in Asia, and plenty of material to occupy the attention of our geographical societies.

Coming to the map of Africa, we find the most marvellous transformation during the last sixty years, and mainly during the last forty years, dating from Livingstone's memorable journey across the continent. Though the north of Africa was the home of one of the oldest civilizations, and though on the shores of the Mediterranean, Phœnicians, Carthaginians, Greeks, and Romans were at work for centuries, it has only been within the memory of many of us that the centre of the continent, from the Sahara to the confines of Cape Colony, has ceased to be an unexplored blank. This blank has been filled up with bewildering rapidity. Great rivers and lakes and mountains have been laid down in their main features, and the whole continent, with a few unimportant exceptions, has been parcelled out among the Powers of Europe. But much still remains to be done ere we can form an adequate conception of what is in some respects the most interesting and the most intractable of the continents. Many curious problems still remain to be solved. The pioneer work of exploration has to a large extent been accomplished; lines have been run in all directions; the main features have been blocked out. But between these lines the broad meshes remain to be filled in, and to do this will require many years of careful exploration. However, there still remain one or two regions that afford scope for the adventurous pioneer.

To the south of Abyssinia and to the west and north-west of Lake Rudolf, on to the upper Nile, is a region of considerable extent, which is still practically unknown. Again, in the Western Sahara there is an extensive area, inhabited mainly by the intractable Tuaregs, into which no one has been able to penetrate, and of which our knowledge is extremely scanty. Even in the Central Sahara there are great areas which have not been traversed, while in the Libyan desert much remains to be done. These regions are of interest almost solely from the geographical and geological standpoints. But they deserve careful investigation, not only that we may ascertain their actual present condition, but in order, also, that we may try to discover some clues to the past history of this interesting continent. Still, it must be said that the great features of the continent have been so fully mapped during the last half-century that what is required now is mainly the filling-in of the details. This is a process that requires many hands and special qualifications. All over the continent there are regions which will repay special investigation. Quite recently an English traveller, Mr. Cowper, found not far from the Tripoli coast miles of magnificent ruins and much to correct on our maps. If only the obstructiveness of the Turkish officials could be overcome, there is a rich harvest for any one who will go to work with patience and intelligence. Even the interior of Morocco, and especially the Atlas mountains, are but little known. The French, both in Tunis and Algeria, are extending our knowledge southwards. All the Powers who have taken part in the scramble for Africa are doing much to acquire a knowledge of their territories. Germany, especially, deserves praise for the persistent zeal with which she has carried out the exploration of her immense territories in East and West Africa. The men she sends out are unusually well qualified for the work, capable not simply of making a running survey as they proceed, and taking notes on country and people, but of rendering a substantial account of the geology, the fauna, the flora, and the economic conditions. Both in the French and the British spheres good work is also being done, and the map of Africa being gradually filled up. But what we especially want now are men of the type of Dr. J. W. Gregory, whose book on the Great Rift Valley is one of the most valuable contributions to African geography ever made. If men of this stamp would settle down in regions like that of Mount Ruwenzori, or Lake Rudolf, or the region about Lakes Bangweolo and Tanganyika, or in the Atlas, or in many other regions that could be named,

the gains to scientific geography, as well as to the economical interests of Africa, would be great. An example of work of this kind is seen in the discoveries made by a young biologist trained in geographical observation, Mr. Moore, on Lake Tanganyika. There he found a fauna which seems to afford a key to the past history of the centre of the continent, a fauna which, Mr. Moore maintains, is essentially of a salt-water type. Mr. Moore, I believe, is inclined to maintain that the ancient connection of this part of Africa with the ocean was not by the west, as Joseph Thomson surmised, but by the north, through the Great Rift Valley of Dr. Gregory; and he strongly advocates the careful examination of Lake Rudolf as the crucial test of his theory. It is to be hoped that he, or some one equally competent, will have an opportunity of carrying out an investigation likely to provide results of the highest importance.

But there are other special problems connected with this, the most backward and most repellent of continents, which demand serious investigation, problems essentially geographical. One of the most important of these, from the point of view of the development of Africa, is the problem of acclimatization. The matter is of such prime importance that a committee of the Association has been at work for some years collecting data as to the climate of tropical Africa. In a general way we know that the climate is hot and the rainfall scanty; indeed, even the geographers of the Ancient World believed that Central Africa was uninhabitable on account of its heat. But science requires more than generalities, and therefore we look forward to the exact results which are being collected by the committee referred to with much hope. We can only go to work experimentally until we know precisely what we have to deal with. It will help us greatly to solve the problem of acclimatization when we have the exact factors that go to constitute the climate of tropical Africa. At present there is no doubt that the weight of competent opinion—that is, the opinion of those who have had actual experience of African climate, and of those who have made a special study of the effects of that climate on the human constitution—is that, though white men, if they take due precautions, may live and do certain kinds of work in Tropical Africa, it will never be possible to colonize that part of the world with people from the temperate zone. This is the lesson taught by generations of experience of Europeans in India. So far, also, sad experience has shown that white people cannot hope to settle in Central Africa as they have settled in Canada and the United States and in Australia, and make it a nursery and a home for new generations. Even in such favourable situations as Blantyre, a lofty region on the south of Lake Nyasa, children cannot be reared beyond a certain age; they must be sent home to England, otherwise they will degenerate physically and morally. No country can ever become the true home of a people if the children have to be sent away to be reared. Still, it is true our experience in Africa is limited. It has been maintained that it might be possible to adapt Europeans to Tropical Africa by a gradual process of migration. Transplant Southern Europeans to North Africa; after a generation or two, remove their progeny further south; and so on, edging the succeeding generation further and further into the heart of the continent. The experiment—a long one it would be—might be tried; but it is to be feared that the ultimate result would be a race deprived of all those characteristics which have made Europe what it is. An able young Italian physician, Dr. Sambon, has recently faced this important problem, and has not hesitated to come to conclusions quite opposed to those generally accepted. His position is that it has taken us centuries in Europe to discover our hidden enemies, the microbes of the various diseases to which northern humanity is a prey, and to meet them and conquer them. In Africa we have a totally different set of enemies to meet, from

lions and snakes down to the invisible organisms that produce those forms of malaria, anæmia, and other diseases characteristic of tropical countries. He admits that these are more or less due to heat, to the nature of the soil, and other tropical conditions, but that if once we knew their precise nature and modes of working we should be in a position to meet them and conquer them. It may be so, but this is a result that could only be reached after generations of experience and investigation; and even Dr. Sambon admits that the ultimate product of European acclimatization in Africa would be something quite different from the European progenitors. What is wanted is a series of carefully conducted experiments. I have referred to the Blantyre highlands; in British East Africa there are plateaus of much greater altitude, and in other parts of Central Africa there are large areas of 4000 feet and over above sea-level. The world may become so full that we may be forced to try to utilize these lofty tropical regions as homes for white people when Canada and Australia and the United States become over-populated. As one of my predecessors in this chair (Mr. Ravenstein) tried to show at the Leeds meeting some years ago, the population of the world will have more than doubled in a century, and about 180 years hence will have quadrupled. At any rate, here is a problem of prime importance for the geographer of the coming century to attack; with so many energetic and intelligent white men all over Africa, it should not be difficult to obtain the data which might help towards its solution.

I have dwelt thus long on Africa, because it will really be one of the great geographical problems of the coming century. Had it been as suitable as America or Australia, we may be sure it would not have remained so long neglected and despised by the European peoples as it has done. Unfortunately for Africa, just as it had been circumnavigated, and just as Europeans were beginning to settle upon its central portion and trying to make their way into the interior, Columbus and Cabot discovered a new world, a world as well adapted as Europe for the energies of the white races. That discovery postponed the legitimate development of Africa for four centuries. Nothing could be more marked than the progress which America has made since its re-discovery four hundred years ago, and the stagnation of Africa which has been known to Europe since long before the beginning of history. During these four hundred years North America at least has been very thoroughly explored. The two great nations which divide North America between them have their government surveys, which are rapidly mapping the whole continent and investigating its geology, physical geography, and its natural resources. I need hardly tell an audience like this of the admirable work done by the Survey of Canada under Sir William Logan, Dr. Selwyn, and his successor, Dr. George Dawson; nor should it be forgotten that under the Lands Department much excellent topographical work has been carried out by Captain Deville and his predecessors. Still, though much has been done, much remains to be done. There are large areas which have not as yet even been roughly mapped. Within quite recent years we have had new regions opened up to us by the work of Dawson and Ogilvie on the Yukon, by Dr. Bell in the region to the south of Hudson bay, by the brothers Tyrrell in the Barren Lands on the west of the same bay, by O'Sullivan beyond the sources of the Ottawa, and by Low in Labrador. But it is not so long since that Dr. Dawson, in reviewing what remains to be done in the Dominion in the way of even pioneer exploration, pointed out that something like a million square miles still remained to be mapped. Apart from the uninhabitable regions in the north, there are, as Dr. Dawson pointed out, considerable areas which might be turned to profitable agricultural and mining account of which we know little, such areas as those which, as already mentioned, have been recently mapped on the south of Hudson bay and beyond the Ottawa. Although the eastern and the western provinces have been very fully

surveyed, there is a considerable area between the two lying between Lake Superior and Hudson bay which seems to have been so far almost untouched. A very great deal has been done for the survey of the rivers and lakes of Canada. I need hardly say that in Canada, as elsewhere in America, there is ample scope for the study of many problems in physical geography—past and present glaciation and the work of glaciers, the origin and *régime* of lake-basins, and the erosion of river-beds, the oscillation of coast-lines. Happily, both in Canada and the United States there are many men competent and eager to work out problems of this class, and in the reports of the various surveys, the transactions of American learned societies, in scientific periodicals, in separate publications, a wealth of data has already been accumulated of immense value to the geographer.

Every geologist and geographer knows the important work which has been accomplished by the various surveys of the United States, as well as by the various State surveys. The United States Coast Survey has been at work for more than half a century, mapping not only the coast, but all the navigable rivers. The Lake Survey has been doing a similar service for the shores of the great lakes of North America. But it is the work of the Geological Survey which is best known to geographers—a survey which is really topographical as well as geological, and which, under such men as Hayden, King, and Powell, has produced a series of magnificent maps, diagrams and memoirs of the highest scientific value and interest. Recently this survey has been placed on a more systematic basis; so that now a scheme for the topographical survey of the whole of the territory of the United States is being carried out. Extensive areas in various parts of the States have been already surveyed on different scales. It is to be hoped that in the future, as in the past, the able men who are employed on this survey work will have opportunities of working out the physiography of particular districts, the past and present geography of which is of advancing scientific interest. Of the complete exploration and mapping of the North American continent we need have no apprehension; it is only a question of time, and it is to be hoped that neither of the governments responsible will allow political exigencies to interfere with what is really a work of national importance.

It is when we come to Central and South America that we find ample room for the unofficial explorer.* In Mexico and the Central American States there are considerable areas of which we have little or only the vaguest knowledge. In South America there is really more room now for the pioneer explorer than there is in Central Africa. In recent years the Argentine Republic has shown a laudable zeal in exploring and mapping its immense territories, while a certain amount of good work has also been done by Brazil and Chili. Most of our knowledge of South America is due to the enterprise of European and North American explorers. Along the great river courses our knowledge is fairly satisfactory, but the immense areas, often densely clad with forests, lying between the rivers are almost entirely unknown. In Patagonia, though a good deal has recently been done by the Argentine Government, still in the country between Punta Arenas and the Rio Negro, we have much to learn; while on the west coast range, with its innumerable fjord-like inlets, its islands and peninsulas, there is a fine field for the geologist and physical geographer. Indeed, throughout the whole range of the Andes systematic exploration is wanted, exploration of the character of the excellent work accomplished by Whymper in the region around Chimborazo. There is an enormous area lying to the east of the Northern Andes, and including their eastern slopes, embracing the

* I am indebted for much of the information relative to South America to a valuable Memorandum by Sir Clements R. Markham and Colonel G. E. Church.

eastern half of Ecuador and Colombia, Southern Venezuela, and much of the country lying between that and Northern Bolivia, including many of the upper tributaries of the Amazon and Orinoko, of which our knowledge is of the scantiest. Even the country lying between the Rio Negro and the Atlantic is but little known. There are other great areas, in Brazil and in the Northern Chaco, which have only been partially described, such as the region whence the streams forming the Tapajos and the Paraguay take their rise, in Mato Grosso. A survey and detailed geographical and topographical description of the whole basin of Lake Titicaca is a desideratum. In short, in South America there is a wider and richer field for exploration than in any other continent. But no mere rush through these little-known regions will suffice. The explorer must be able not only to use his sextant and his theodolite, his compass, and his chronometer; any expeditions entering these regions ought to be able to bring back satisfactory information on the geology of the country traversed, and of its fauna and flora, past and present. Already the revelations which have been made of the past geography of South America, and of the life that flourished there in former epochs, are of the highest interest. Moreover, we have here the remains of extinct civilizations to deal with, and although much has been done in this direction, much remains to be done, and in the extensive region already referred to, the physique, the traditions, and the customs of the natives will repay careful investigation.

The southern continent of Australia is in the hands of men of the same origin as those who have developed to such a wonderful extent the resources of Canada and the United States, and therefore we look for equally satisfactory results so far as the characteristics of that continent permit. The five colonies which divide among them the 3,000,000 square miles of the continent have each of them efficient Government surveys, which are rapidly mapping their features and investigating their geology. But Australia has a trying economic problem to solve. In none of the colonies is the water-supply quite adequate; in all are stretches of desert country of greater or less extent. The centre and western half of the continent is covered by a desert more waterless and more repellent than even the Sahara; so far as our present knowledge goes, one-third of the continent is uninhabitable. This desert area has been crossed by explorers, at the expense of great sufferings, in various directions, each with the same dreary tale of almost featureless sandy desert, covered here and there with spinifex and scrub, worse than useless. There are hundreds of thousands of square miles still unknown, but there is no reason to believe that these areas possess any features that differ essentially from those which have been found along the routes that have been explored. There have been one or two well-equipped scientific expeditions in recent years that have collected valuable data with regard to the physical characteristics, the geology and biology of the continent; and it is in this direction that geography should look for the richest results in the future. There remains much to be done before we can arrive at satisfactory conclusions as to the physical history of what is in some respects the most remarkable land area on the globe. Though the surface water-supply is so scanty, there is reason to believe that underneath the surface there is an immense store of water. In one or two places in Australia, especially in Western Queensland, and in New South Wales, this supply has been tapped with satisfactory results; millions of gallons a day have been obtained by sinking wells. Whether irrigation can ever be introduced on an extensive scale into Australia depends upon the extent and accessibility of the underground water-supply, and that is one of the geographical problems of the future in Australia. New Zealand has been fairly well surveyed, though a good deal remains to be done before its magnificent mountain and glacier system is completely known. In the

great island of New Guinea both the British and the Germans are opening up the interiors of their territories to our knowledge, but the western and much larger portion of the island presents a large field for any explorer who cares to venture into its interior.

The marvellous success which has attended Dr. Nansen's daring adventure into the arctic seas has revived a widespread interest in polar exploration. Nansen may be said to have almost solved the north polar problem—so far, at least, as the Old World side of the pole is concerned. That some one will reach the pole at no distant date is certain; Nansen has shown the way, and the legitimate curiosity of humanity will not rest satisfied till the goal be reached. But arctic exploration does not end with the attainment of the pole. Europe has done her share on her own side of the pole; what about the side which forms the Hinterland of North America, and specially of Canada? To the north of Europe and Asia we have the scattered groups of islands, Spitsbergen, Franz Josef Land, Novaya Zemlya, and the New Siberian islands. To the north of America we have an immense archipelago, the actual extent of which is unknown. Nansen and other arctic authorities maintain that the next thing to be done is to complete exploration on the American side, to attempt to do for that half of the north polar region what Nansen has done for the other half. It may be that the islands which fringe the northern shores of the New World are continued far to the north; if so they would form convenient stages for the work of a well-equipped expedition. It may be that they do not go much further than we find them on our maps. Whatever be the case, it is important, in the interests of science, that this section of the polar area be examined; that as high a latitude as possible be attained; that soundings be made to discover whether the deep ocean extends all round the pole. It is stated that the gallant Lieut. Peary has organized a scheme of exploring this area which would take several years to accomplish. Let us hope that he will be able to carry out his scheme. Meantime, should Canada look on with indifference? She has attained the standing of a great and prosperous nation. She has shown the most commendable zeal in the exploration of her own immense territory. She has her educational, scientific, and literary institutions which will compare favourably with those of other countries; her press is of a high order, and she has made the beginnings of a literature and an art of her own. In these respects she is walking in the steps of the Mother Country. But has Canada not reached a stage when she is in a position to follow the maternal example still further? What has more contributed to render the name of Great Britain illustrious than those great enterprises which for centuries she has sent out from her own shores, not a few of them solely in the interests of science? Such enterprises elevate a nation and form its glory and its pride. Surely Canada has ambitions beyond mere material prosperity, and what better beginning could be made than the equipment of an expedition for the exploration of the seas that lie between her and the pole? I venture to throw out these suggestions for the consideration of those who have at heart the honour and glory of the great Canadian dominion.

Not only has an interest in arctic exploration been revived, but in Europe at least an even greater interest has grown up in the exploration of the region around the opposite pole of the Earth of which our knowledge is so scanty. Since Sir James C. Ross's expedition, which was sent out in the year 1839, almost nothing has been done for antarctic research. We have here to deal with conditions different from those which surround the north pole. Instead of an almost landless ocean, it is believed by those who have given special attention to the subject that a continent about the size of Australia covers the south polar region. But we do not know for certain, and surely, in the interests of our

science, it is time we had a fairly adequate idea of what are the real conditions. We want to know what is the extent of that land, what are its glacial conditions, what is the character of its geology, what evidence exists as to its physical and biological conditions in past ages? We know there is one lofty, active volcano; are there any others? Moreover, the science of terrestrial magnetism is seriously impeded in its progress because the data in this department from the antarctic are so scanty. The seas around this continent require to be investigated both as to their depth, their temperature, and their life. We have here, in short, the most extensive unexplored area on the surface of the globe. For the last three or four years the Royal Geographical Society, backed by other British societies, has been attempting to move the Home Government to equip an adequate expedition to complete the work begun by Ross sixty years ago, and to supplement the great work of the *Challenger*. But though sympathy has been expressed for antarctic exploration, and though vague promises have been given of support, the Government is afraid to enter upon an enterprise which might involve the services of a few naval officers and men. We need not criticize this attitude. But the Royal Geographical Society has determined not to let the matter rest here. It is now seeking to obtain the support of public-spirited men for an antarctic expedition under its own auspices. It is felt that antarctic exploration is peculiarly the work of England, and that if an expedition is undertaken, it will receive substantial support from the great Australasian colonies, which have so much to gain from a knowledge of the physical condition of a region lying at their own doors, and probably having a serious influence on their climatological conditions. Here, then, is one of the greatest geographical problems of the future, the solution of which should be entered upon without further delay. It may be mentioned that a small and well-equipped Belgian expedition has already started, mainly to carry out deep-sea research around the south polar area, and that strenuous efforts are being made in Germany to obtain the funds for an expedition on a much larger scale.

But our science has to deal not only with the lands of the globe; its sphere is the whole of the surface of the Earth, and all that is thereon, so far at least as distribution is concerned. The department of oceanography is a comparatively new creation; indeed, it may be said to have come definitely into being with the famous voyage of the *Challenger*. There had been expeditions for ocean investigation before that, but on a very limited scale. It has only been through the results obtained by the *Challenger*, supplemented by those of expeditions that have examined more limited areas, that we have been able to obtain an approximate conception of the conditions which prevail throughout the various ocean depths—conditions of movement, of temperature, of salinity, of life. We have only a general idea of the contours of the ocean-bed, and of the composition of the sediment which covers that bed. The extent of the knowledge thus acquired may be gauged from the fact that it occupies a considerable space in the fifty quarto volumes—the 'Challenger Publications'—which it took Dr. John Murray twenty years to bring out. But that great undertaking has only, as it were, laid down the general features of the oceanic world. There is plenty of room for further research in this direction. Our own surveying ships, which are constantly at work all over the world, do a certain amount of oceanic work, apart from mere surveying of coasts and islands and shoals. In 1895 one of these found in the South Pacific soundings deeper by 500 fathoms than the deepest on record, that found twenty years earlier by the *Tuscarora* to the north-east of Japan. The deepest of these new soundings was 5155 fathoms. In the interests of science, as well as of cable-laying, it is desirable that our surveying ships should be encouraged to carry out work of this kind more systematically than they do at present. This could surely be arranged

without interfering with their regular work. We want many more observations than we now have, not only on ocean depths, but on the nature of the ocean-bed, before we can have a satisfactory map of this hidden portion of the Earth's surface, and form satisfactory conclusions as to the past relations of the ocean-bed with what is now dry land. I believe the position is maintained by geologists, that from the remote period when the great folds of the Earth were formed the present relations between the great land-masses and the great oceans have been essentially the same; that there have no doubt been great changes, but that these have been within such limits as not to materially affect their relations as a whole. This is a problem which further oceanic research would go a long way to elucidate. That striking changes are going on at the present day, and have been going on within the human period, cannot be doubted. Some coast-lines are rising; others are falling. Prof. John Milne, our great authority on seismology, has collected an extremely interesting series of data, as to the curious changes that have taken place in the ocean-bed since telegraphic cables have been laid down. The frequent breakages of cables have led to the examination of the sub-oceanic ground on which they have been laid, and it is found that slides and sinkings have occurred, in some cases amounting to hundreds of fathoms. These, it is important to note, are on the slopes of the Continental Margin, or, as it is called, the Continental Shelf, as, for example, off the coast of Chili. It is there, where the Earth's crust is peculiarly in a state of unstable equilibrium, that we might expect to find such movements; and therefore soundings along the continental margins, at intervals of say five years, might furnish science with data that might be turned to good account.

As an example of what may be done by a single individual to elucidate the present and past relations between land and sea, may I refer to an able paper in the *Geographical Journal* of May, 1897, by Mr. T. P. Gulliver, a pupil of Prof. Davis, of Harvard, himself one of the foremost of our scientific geographers? Mr. Gulliver has made a special study on the spot, and with the help of good topographical and geological maps, of Dungeness Foreland, on the south-east coast of Kent. Mr. Gulliver takes this for his subject, and works out with great care the history of the changing coast-line here, and in connection with that the origin and changes of the English Channel. This is the kind of work that well-trained geographical students might undertake. It is work to be encouraged, not only for the results to be obtained, but as one species of practical geographical training in the field, and as a reply to those who maintain that geography is mere bookwork, and has no problems to solve. Prof. Davis himself has given an example of similar practical work in his elaborate paper on 'The Development of Certain English Rivers' in the *Geographical Journal* for February, 1895 (vol. v. p. 127), and in many other publications.

Another important problem to attack, and that in the near future, is that of Oceanic islands. I say in the near future, because it is to be feared that very few islands now remain unmodified by contact with Europeans. Not only have the natives been affected, both in physique and in customs, but the introduction of European plants and animals has to a greater or less extent modified the native fauna and flora. Dr. John Murray, of the *Challenger*, has set a good example in this direction by sending a young official from the Natural History Museum to Christmas island, in the Indian ocean, one of the few untouched islands that remain, lying far away from any other land, to the south-east of the Keelings.

What islands are to the ocean, lakes are to the land. It is only recently that these interesting geographical features have received the attention they deserve. Dr. Murray has for some time been engaged in investigating the physical

conditions of some of the remarkable lakes in the west of Scotland. Some three years ago my friend and colleague, Dr. Mill, carried out a very careful survey of the English lakes, under the auspices of the Royal Geographical Society. His soundings, his observations of the lake conditions, of the features on the margins of and around the lakes, when combined with the investigation of the *régime* of the rivers and the physical geography of the surrounding country, conducted by such accomplished geologists as Mr. Marr, afford the materials for an extremely interesting study in the geographical history of the district. On the Continent, again, men like Prof. Penck, of Vienna, have been giving special attention to lakes, that accomplished geographer's monograph on Lake Constance, based on the work of the five states bordering its shores, being a model work of its kind. But the father of Limnology, as this branch of geography is called, is undoubtedly Prof. Forel, of Geneva, who for many years has been investigating the conditions of that classical lake, and who is now publishing the results of his research. Dr. Forel's paper on 'Limnology: a Branch of Geography,' and the discussion which follows in the Report of the last International Geographical Congress, affords a very fair idea in short space of the kind of work to be done by this branch of the science. In France, again, M. Delebecque is devoting himself to a similar line of research; in Germany Ule, Halbfass, and others; Richter in Austria, and the Balaton Commission in Hungary. I may also here refer appropriately to Mr. Israel C. Russell's able work, published in Boston in 1895, on 'The Lakes of North America,' in which the author uses these lakes as a text for a discourse on the origin of lake basins and the part played by lakes in the changes studied by dynamic geology. Some of the best examples of an exhaustive study of a lake basin will be found in the magnificent monograph on Lake Bonneville, by Mr. G. K. Gilbert, and that on Lake Lahontan by Mr. Israel Cook Russell, published by the United States Geological Survey; the former is indeed a complete history of the great basin, the largest of the interior drainage areas of the North American continent. In the publications of the various surveys of the United States, as well as in the official reports of the Canadian Lake surveys, a vast amount of material exists for any one interested in the study of lakes; in addition, there are the elaborate special Reports on the great lakes by the Hydrographic Department. Indeed, North America presents an exceptionally favourable field for limnological investigation; if carried out on a systematic method, the results could not but be of great scientific interest.

Rivers are of not less geographical interest than lakes, and these have also recently been the subject of special investigation by physical geographers. I have already referred to Prof. Davis's study of a special English river system. The work in the English Lake District by Mr. Marr, spoken of in connection with Dr. Mill's investigations, was mainly on the hydrology of the region. Both in Germany and in Russia special attention is being given to this subject, while in America there is an enormous literature on the Mississippi alone, mainly, no doubt, from the practical standpoint, while the result of much valuable work on the St. Lawrence is buried in the Canadian official publications.

But time does not admit of my going farther. I might have pointed out the wide and vastly interesting field presented by what the Germans call Anthropogeography, dealing with the interrelations between humanity and its geographical environment. Geography, Mr. Mackinder has said, is the physical basis of history; it is, indeed, the physical basis of all human activity, and from that standpoint the field for geographical research is unbounded. But I can only hint at this. I have endeavoured to indicate what are some of the leading geographical problems of the future, first in order to show at this somewhat critical epoch how very much yet remains to be done, how many important lines of inquiry are open to the

geographical student, and that the possibilities of our science are, like those of other departments of research, inexhaustible. My aim has also been to indicate by actual examples what, in the conception of British geographers at least, is the field of our subject. We need not trouble greatly about any precise definition so long as there is such a choice of work for the energies of the geographer. I trust I have been, to some extent at least, successful in the double object which I have had in view in this opening address in a country which presents so splendid a field to the practical geographer.

THE MONTHLY RECORD.

EUROPE.

The Lakes of the Riesen Gebirge.—The investigations, begun in 1895, relating to the mountain lakes known as the "Koppenteiche," were continued in 1896 by Dr. Otto Zacharias. His researches show that the average amount of "Plankton" (micro-fauna) contained in them is only the tenth or twentieth part of that contained in the standing waters of the North German lowlands, so that in a biological sense they may be put down as "desert." This holds especially in the case of the Greater Koppenteich (altitude 3996 feet), whilst the Lesser Koppenteich (altitude 3832 feet), with an area only one-sixth as large, is much more favourably placed. During three weeks in June and July the amount of "Plankton" in the latter proved to be from 0·0004 to 0·0006 per hundred parts of water, while in the former it only reached the small percentage of from 0·00035 to 0·0004. Thus the smaller lake has just enough to fit it for fish-culture (*Coregonus marena*), but not so the larger. As regards the micro-flora of the mud on the lake-bottom (*Diatomaceæ*), a special interest attaches to the presence of *Stenopterobia anceps*. This remarkable and scarce species has hitherto been found only in North America, on the Puy de Dôme (central plateau of France), and in Cornwall. The three small "Kochelteiche" (altitude 4068 feet), which lie in the region of moraines, dating from the Glacial epoch, known as the "Grosse Schneegrube," are marked by a great abundance of diatoms. The general character of the flora is sub-alpine or sub-arctic. Simultaneous determinations of temperature gave (for the afternoon in the middle of July) the following results:—

	Surface.	At 6 metres (19·7 ft.) depth.	At 23 metres (75·5 ft.) depth.
Greater Koppenteich	56·3° Fahr.	51·8° Fahr.	50° Fahr. (bottom)
Lesser Koppenteich	57° Fahr.	49·6° Fahr. (bottom)	—

In the latter the most rapid fall occurred between the surface and a depth of 5 feet, with a difference of 4·1° Fahr., and in the former between 8·2 and 16·4 feet, with a difference of 5° Fahr. A remarkable fact is the comparatively high temperature at the bottom of the larger lake, as also the high level of the zone of most rapid fall of temperature in both. The last circumstance is possibly connected with the length of time that both lakes remain in shadow.

The Botanical Geography of Middle Albania and Epirus.—To the July number of *Petermanns Mitteilungen* Dr. Antonio Baldacci contributes the

first part of a paper setting forth the results of his explorations made in this region, with an eye to the geographical distribution of plants, both wild and cultivated. Among the most interesting observations from a geographical point of view is the fact that, apparently in consequence of the shelter afforded from cold northerly and north-easterly winds by the Dinaric Alps and the other maritime ranges on the west side of the Balkan peninsula, numbers of characteristic Mediterranean forms reach much further north on the eastern than on the western shores of the Adriatic. A map on the scale of 1 : 1,000,000 which accompanies the paper, distinguishes the areas occupied by the characteristic Mediterranean vegetation (the *maquis* of the French, *macchie* of the Italians), as representing which, at least in the parts explored, Dr. Baldacci attaches most importance to the *Quercus coccifera*, the mountain forest region (with conifers, Cupuliferæ, etc.), the high mountain region, and swamps, and indicates the place of occurrence of the olive and the Citrus genus, the *Quercus Ægilops* and *Quercus Grisebachii*, the *Cytisus Weldeni*, the *Æsculus Hippocastanum*, the *Nerium Oleander*, *Arce*, *Uthobium*, and *Oxicedri*.

The Wanderings of Prince Charles Edward in 1745.—The latest publication of the Scottish History Society takes the form of a chronological itinerary of the movements of the young Pretender from his arrival in Scotland on June 22, 1745, to his departure for France on September 28, 1746. Mr. W. B. Blaikie, whose ingeniously constructed cosmosphere has been exhibited to the Royal Geographical Society, has shown himself to be no less successful as a student of old topography than as a mathematical geographer. The difficulty of determining the exact stopping-places and the routes followed during the romantic wanderings through the West Highlands which preceded the escape of the Pretender, is clear to any one who has considered the contradictions of published records; but all the difficulties in this case have been overcome. The routes have been placed upon a modern map, and are shown in three colours—red for the rapid advance to Derby, green for the retreat to Inverness, and blue for the flight after Cullodon. In this way the different visits to some of the places are shown with great distinctness. It was the author's first intention to have reproduced a contemporary map, but, on account of the defective topography of all of these, he decided that they would be less serviceable than a map based on the Ordnance Survey. It is interesting to recall that the commencement of the Ordnance Survey of the United Kingdom was, like the laying out of the Highland roads, a direct result of the rising in 1745. In a very interesting note on contemporary maps, Mr. Blaikie describes three—one showing the routes of the Pretender by Colonel J. A. Grante, in a French and English edition (both in the British Museum); the second apparently a copy published anonymously in Rome, and now very rare; it is not in the British Museum, the only copy known being in Lord Crawford's collection. The third map could not be identified for some time. It was referred to by Bishop Forbes as the work of John Finlayson, and its identification is an example of acute literary research. Mr. Blaikie found in Scotland a map without name, imprint, or date, but in its title claiming to show "even the secret Routs of the Pr after the battle of Culloden until his Escape to France." In a petition of John Finlayson, when in prison after Culloden, he begs for the return of the plates of his maps; and in another letter he says, "If the contraction Pr give any offence, it can be altered." Other pieces of internal evidence placed the identity of the newly discovered map with Finlayson's beyond doubt. The ingenious author had, of course, endeavoured to secure the favour of both sides for his work by using a contraction which would stand for "Pretender" with the supporters of the Government, and for "Prince" with the Jacobites.

ASIA.

Reports on Burmese Frontier Districts.—During the various minor military expeditions which have been sent to outlying districts of Upper Burma, much geographical information has been collected, and is embodied in the reports of the officers of the Intelligence branch, a number of which have lately been received from the headquarters of that department at Simla. They deal with districts in the north-east, north, and west of Burma, including the northern and least-known parts of the Shan states, the country of the Sana Kachins, on the upper Irawadi, and the Chin hills. All are abundantly supplied with route-maps and sketches of the country passed through. Lieut. C. E. Macquoid reports on a tour made in 1895–96, in the Shan states beyond the Salwin, near the Chinese frontier. The district is chiefly occupied by small Wa states not yet brought under British control, and on the Chinese frontier by savage Wa tribes, still unvisited by Europeans. The Wa states are reported to be very populous. A great quantity of opium is grown, but the country is, as yet, exceedingly poor. No bazaars are held, and there is practically no currency. Reports of the existence of gold are, however, current. On a preliminary trip, Lieut. Macquoid visited the country somewhat farther north, on the east bank of the Salwin, which has hitherto been little known. Pan-Long, a settlement of Panthays, he found to be a prosperous trading centre, and, from its nearness to the future terminus of the Salwin railway, it is likely to become a town of much importance. Between Mandalay and Thibaw the construction of the line was progressing rapidly. A report by Lieut. M. N. Turner has to do with the Sana Kachin expedition of 1895–96. The country of the Sana Kachins lies between the Mali-Kha, or western branch of the Irawadi, and the Kumon range, which forms a barrier on the side of the Hukong valley. It is generally covered with jungle, relieved only by the brown patches which mark the annual clearings of the inhabitants. Bamboos are found everywhere. The general surface is broken, consisting of low steep hills and narrow valleys. A lofty, probably snow-capped range was just visible to the north-east. Lieut. E. S. Carey gives an account of a visit to the jade-mines district east of the Chindwin river, of which Kansi is the principal village. The Kachins of the district build very large houses, which are open to all comers. The Kansi-la, who is the headman of the whole tract, sometimes entertains 100 to 150 guests per night. Besides jade, which is obtained by diving from the bed of the rivers as well as from the mines, rubies and salt are the principal products of the country. Gold is also found. The climate is pleasant by day, but the nights are sometimes unpleasantly cold. Two reports deal with the Chin hills, which, however, are described more fully in the work noticed in the last number of the *Journal* (p. 211).

Surveys in Northern and Central Persia.—During the year 1895, extensive journeys in Northern and Central Persia were made by A. F. Stahl, formerly Director of Posts in that country, chiefly with a view to mineralogical and geological investigations. Valuable results with reference to the topography of the country passed through were also obtained, and these have been published as a supplementary number of *Petermanns Mitteilungen* (No. 118, 1896). The letterpress, which gives a detailed description of the principal routes followed, is accompanied by three maps on the large scale of 1 : 825,000, itself a fourfold reduction from the original scale of the surveys. The map issued by the Russian General Staff was taken by Herr Stahl as the basis for his map as regards the positions of the principal towns, but the intervening country is laid down entirely from his own work, the parts not visited by him being left blank. His routes, however, especially in the Northern Persian highlands, form such a complete network over the country,

that his map shows in detail the features of by far the larger part of the surface. A comparison of Herr Stahl's map with that of Colonel Lovett, published in the R.G.S. *Proceedings* for 1883, and with the Society's map of Persia published in 1892, shows some of the alterations which have been introduced as a result of the German traveller's surveys. The Lar or Lahr, the upper course of the Harhaz or Heraspei, has been followed up almost to its source in about 51° 30′ E., and the course of the Nur, the principal tributary of the same river, has been determined. Herr Stahl places Mount Devavend slightly to the west of the position assigned to it in the Society's map, with the result that the Harhaz, after encircling the mountain, has rather a north-north-easterly than a northerly course. The main channel of the river is also shown as lying entirely to the east of the Amol-Mahmudabad railway, and as having no connection with the stream which enters the sea at the latter place. In Central Persia Herr Stahl's routes did not cover the country so thickly, but they extended in various directions on either side of the direct line from Kum to Yezd and Kerman. Throughout this distance the country offers no hindrances to the construction of a good road, but the traffic would not repay the outlay. Between Naïn and Anarek Herr Stahl found a marked line of depression, which does not appear to be shown on previous maps. The lowest point cannot be much more than 3000 feet above the sea. As regards the formation of the Persian salt-deserts, he rather attributes it to the action of atmospheric precipitation than to purely aërial causes.

AFRICA.

Captain Bòttego's Expedition.—A report by Lieuts. Vannutelli and Citerni, the European survivors of Captain Bòttego's expedition, is published in the *Bolletino* of the Italian Geographical Society (1891, No. 8). From the Daua (*Journal*, vol. viii. p. 516) the expedition made its way to the Amara country on the left bank of the Sagan, in about 5° 23′ N., 38° 15′ E. This river is evidently the Galana Amara of Dr. Donaldson Smith, which enters Lake Stefanie. After visiting Lake Pagade, the Wallamo country, and the Omo, it proceeded southwards to Lake Rudolf, and after again exploring the Sagan, followed the unvisited western shore of that lake to about 3° 8′ S. In November, 1896, Dr. Sacchi returned southwards towards Lugh with the collections, while the bulk of the expedition continued in a north-westerly direction along the western edge of the Ethiopian highlands. The unhealthy nature of the country induced Captain Bòttego to make for the mountains, ascending the river Upeno (apparently the Baro or an affluent), and relations were entered into with the Galla Chief of Lega and Sajo, whose residence appears to have been close to Gobo, reached by J. M. Schuver in 1892. The chief, however, proved treacherous, and the encounter in which Captain Bòttego lost his life took place. The survivors were held captive for some time, but were finally sent to Adis Abeba by order of Menelek. Colonel Leontieff, in a letter to the *Novoye Vremia*, reproduced in the Italian *Bolletino*, states that Bòttego succeeded in proving the identity of the Omo with the Sobat, thus verifying the view taken by Dr. Beke so far back as 1848. The Italian officers, however, appear to be silent on this point. Prof. Keller, who has himself made extensive journeys in Somaliland, writes concerning the fate of Dr. Sacchi, which is still involved in some obscurity. A recent telegram from Zanzibar seems to indicate that he was killed in an Abyssinian raid in the country of the Boran Gallas. A part of the scientific notes collected by the main expedition after his departure have been saved.

The Southern Borderlands of German East Africa.—When Baron v. Schele and Captain Ramsay, in 1894, made their way from Amelia bay on Lake Nyasa to Kilwa, by a new route across the southern part of the Rufiji basin, Herr

Lieder, the geologist of the expedition, was sent southwards to Mpamba bay, in order to explore a more southerly route from that point to the coast. Captain Ramsay's large-scale map was published in 1894 in the *Mitteilungen aus den Deutschen Schutzgebieten*, and the same valuable publication now gives (1897, part 2) a detailed account of Lieder's journey, accompanied by a map on the scale of 1 : 800,000. Herr Lieder's account gives a large amount of information on the physical geography, as well as on the inhabitants, trade routes, etc., of the country traversed. The route from Mpamba bay, though used by small trading caravans, is far more difficult than that from Amelia bay, the ascent to the high plateau which separates Lake Nyasa from the headwaters of the Rovuma being steep, and the paths bad: The whole country around the Rovuma sources—an undulating plateau about 3000 feet above the sea—is inhabited by the Wangoni, known to the coast peoples as Magwangwara from the Lumagwangwara, a tributary to the Rovuma. Since they have been cut off from intercourse with the more southern Zulus, they have mixed with the natives of the country, and have even lost their Zulu speech, although their customs have been adopted by the subject tribes. In the southern part of their district a small settlement of coast traders was founded in 1890. The granite of the region of Mpamba bay soon gives place eastward to gneiss, which, sometimes with a surface layer of laterite, occupies most of the Wangoni country. Still further east the plateau between the Rufiji and Rovuma basins is in great measure composed of sandstone. The route led along its southern margin, which is deeply cut by streams flowing to the Rovuma, and overlooks a much lower tract of country in that direction. The surface was generally covered with thin tree-savannah, with very little undergrowth. It is entirely uninhabited, though traces of a former population were everywhere visible. The sandstone region ends at the Mohessi, the only stream on this route to the coast which presents any difficulties to caravans. In the rainy season it attains a breadth of nearly 300 yards and a depth of 15 feet, and is impassable. Beyond this the route led through a better-known country. At Masasi the Rovuma basin was left, and the way to Kilwa followed the northern edge of the Mwera plateau, which bounds the basin of the Umbekuru on the south.

Journeys in German East Africa.—We learn from the *Deutsches Kolonialblatt* (May 15) that G. Schillings, who accompanied Dr. Schoeller on his expedition to the Victoria Nyanza, has, since his return to the coast, made a new journey to the Masai steppe, for the purpose of reaching the Lake Kiniarok reported by Dr. Fischer and Dr. Baumann. Three forced marches over the waterless steppe brought the traveller to a series of small lakes, twelve in number, formed by the accumulation of rain-water in the hollows of the surface rock, some being of considerable depth. Only three contain water throughout the year. Lake Kiniarok does not exist, but the name applies to a sandy plateau, which from a distance may present the appearance of a lake. Numbers of steep mountains rise from the surface of the plain in the neighbourhood of the lakes, but the scarcity of water prevented their exploration. *Globus* (vol. lxxii. No. 1) publishes news from Zanzibar containing some details respecting Lieut. Werther's expedition (*Journal*, vol. viii. p. 175), which reached the coast in May last. The traveller had succeeded in reaching the summit of Mount Gurui, the ascent of which, to within a few hundred feet of the top, was made in 1894 by Count von Götzen (*Journal*, vol. iv. p. 273). Its height is reckoned by Lieut. Werther at about 10,200 feet. The mountain is undoubtedly an old ruined crater, furrowed by deeply eroded ravines. The diameter of the crater is rather over half a mile. Its wall is broken through on the south-east, but is more intact elsewhere; and Lieut. Werther was able to climb both of its highest segments. A new lake is said to have been discovered by

him in the great East African trough. Two small lakes have also been lately discovered between Mounts Meru and Kilimanjaro by Lieut. Merker (*Mitt. aus den Deutschen Schutzgebieten*, 1896, No. 4). Lieut. Engelhardt has lately made journeys in the *Hinterland* of Lindi (*D. Kolonialblatt*, June 1 and 15), during which he examined the capabilities of the Rovuma as a navigable route into the interior. He thinks that even at high water the stream can never serve as a continuous waterway, although certain sections have depth enough of water to float fairly large craft. The region traversed by him west of Lindi was generally fertile, no barren steppes being met with. The country north of the Rovuma and westward of Masasi is, with the exception of the Majeje mountains, a gently undulating wooded country, well watered by tributaries of the Rovuma. Wax, the produce of wild bees, has been collected in considerable quantities from this district during the last two years. The rubber-supply from the hilly country near the coast has, however, diminished greatly, owing to reckless destruction of the lianas.

Expeditions in the Somali and Galla Lands.—Several expeditions are now in the field, having for their object the completion of the exploration of the countries south of Abyssinia. Count von Wickenburg, an Austrian officer who has spent some time travelling in the East, started from Zeila in April for Harrar and Adis Abeba, whence he hopes to make his way by the Omo and Lake Rudolf to Uganda. The country west of Lake Rudolf is also the objective of Mr. Bennett Stanford, who lately started from Berbera for the interior, accompanied by his wife. A second British expedition is that of Lord Delamere, who has likewise started from Berbera. Dr. Atkinson, Lord Delamere's colleague, is, we understand, making his way from Brava to join the main expedition at Lugh, on the Jub.

Railways in South Africa.—The railway from Cape Colony to Matabeleland had progressed as far as the 382nd mile from Mafeking in the middle of July last, and only 98 miles remained to be laid between the point then reached and Bulawayo. The formal opening is expected to take place in November. Arrangements have already been made to connect Bulawayo with the terminus of the Beira railway, and thus complete the circuit between the south and east coasts of South Africa. The construction of a narrow-gauge line in German South-West Africa has also been decided upon, and the *personnel* and necessary materials were, according to the *Kolonialzeitung*, despatched from Germany early in August.

AMERICA.

The Earliest Use of the Name America.—Although it is well known that the first suggestion of the use of "America" as the designation of the New World was made by Martin Waldseemüller (or "Hylacomylus") in his *Cosmographiæ Introductio* published at St. Dié in 1507, some uncertainty has hitherto prevailed as to the earliest definite adoption of the suggestion by other writers and cartographers. This has been caused by the doubt attaching to the question of the date of the earliest globes, or sets of gores, which contain the name America.* An interesting discovery has lately been made by Prof. Elter, of Bonn, which seems definitely to assign the earliest use of the name (on any map which has come down to us) to the year 1510. In the copy of the 1482 (Ulm) edition of Ptolemy, in the library of Bonn University, he found a manuscript map by the

* Mr. Thacher, in his lately published work on the discovery of America, considers the first map with the name America to be that accompanying the edition of the *Polyhistor*, published at Vienna in 1520.

hand of Henricus Glareanus, dated 1510 in the handwriting of the author, on which the legend "Terra America" appears on the southern portion of the New World. A pamphlet (in Latin) has lately been issued by the Bonn University Press, containing a dissertation by Prof. Elter on the early use of the word America, together with some interesting particulars with reference to Glareanus, showing his services to the cause of geography. Born in 1488, he entered the University of Cologne in 1506, and took his doctor's degree in 1510, the same year in which he drew the map in question. He was made "poet laureate" by the Emperor Maximilian in 1512, and in 1529 became professor at Friburg. Other maps from his hand appear on another page of the Ptolemy above referred to, and also in his own copy of the *Cosmographiæ Introductio*, now in the Munich University library. The former are remarkable as being, perhaps, the first examples of circumpolar charts in existence. He also published in 1827, at Basle, a treatise on geography, which met with such favour that a number of reprints were called for within a few years. The manuscript maps, of which facsimiles accompany the brochure, are of special interest, as helping us in some measure to reconstruct the lost map of Waldseemüller, drawn to accompany the *Cosmographiæ Introductio*. From the statements of Glareanus himself, it is evident that they were based on that lost map, which, could it be found, would no doubt prove to contain the name America. In giving that name to the quarter of the world explored by Americus, Waldseemüller must have intended it to apply only to South America, for, while the four quarters of the globe are distinguished by colours on Glareanus's map, the continental parts of North America are painted of the same colour as Asia, and the West Indian islands are coloured as belonging to Europe. Moreover, North and South America are shown as separated by a strait.

Exploration of the River Aisen, Chili.—The Chilian Expedition, composed of Drs. Steffen and Dusen, O. von Fischer, and others, which started in January last for the exploration of the Aisen, returned in May to Santiago crowned with success (*Globus*, vol. lxxii. p. 51; *Aus allen Weltteilen*, 1897, col. 651). The Aisen empties itself by a broad estuary, in about 45° 20′ S. lat., into the channel which runs behind the Chonos archipelago. Ascending from its mouth, the explorers soon found that it divides into two branches, the larger coming from the north-west, the smaller from the east. Both were explored by separate sections of the expedition. The larger branch was found to spring from a fine glacier, which apparently occupies the watershed between the Aisen and Lake Fontana. Both parties finally reached Lake Nahuelhuapi, and made their way across the cordillera to Puerto Montt. The expedition is said to have shed new light on the Chilian-Argentine boundary question.

The Interoceanic Canal Projects.—Dr. H. Polakowsky, who contributed an account of the Nicaragua canal scheme of Menocal to *Petermanns Mitteilungen* in 1890, again discusses the subject in the June number of that periodical for this year, chiefly with reference to the report of the commission of investigation appointed by President Cleveland (Report of the Nicaragua Canal Board: House of Representatives, Document No. 279, Fifty-fourth Congress, first session). In his former paper Dr. Polakowsky had pointed out the grounds for doubting the advisability of the route adopted for the eastern section of the canal terminating at Greytown, and in his present communication he states that we now know that the Colorado arm of the San Juan delta (in Costa Rican territory) offers a much better route, not merely than that adopted by Menocal from the Ochoa dam across the mountains to Greytown, but also than the bed of the river-arm which retains the name of the San Juan. According to Squier, more than two-thirds, according to Pio Viquez, more than four-fifths, of the volume of the San Juan passes by the

Colorado arm. Moreover, the American commission has confirmed the fact already known that the harbour of Greytown could be kept in a tolerably serviceable condition only at great expense, and it would be much easier to maintain a harbour at the mouth of the Colorado. The cost of construction of the Nicaragua canal is estimated by the commission at 133,470,000 dollars, as against Menocal's estimate of 66,460,000, and the estimate of 69,890,000 dollars made by the Maritime Canal Company of Nicaragua. Dr. Polakowsky, on the other hand, believes that with capable and honest management the cost (exclusive of interest during the period of construction) would amount to between 150 and 160 million dollars, and in these circumstances he asks whether it would not be well for the United States Government, before giving their support to any scheme, to wait till the privilege of the Nouvelle Compagnie Universelle du Canal de Panama expires (October, 1904), and then try to ascertain whether it would not be better to construct a Panama canal without locks even at the cost of 200 to 250 million dollars. He adds that a new scheme laid before the President of the Geographical Society of Berlin by Mr. Karwiese, a German-American, is at least worthy of serious examination. It is a modification of the scheme originally brought forward by Messrs. L. Wyse, Armand Reclus, and P. Sosa. The proposal is to utilize the lower part of the Tuira (the stream that enters the head of the Darien estuary and through that the gulf of San Miguel in the east of Darien), to form a summit basin by damming the Chucunagua, to cross the Cordillera by a tunnel 3 miles long, and to terminate on the Atlantic side at the small port of Acanti (Gandi, Tolo, Estola).

Travels in Colombia.—The July number of *Petermanns Mitteilungen* publishes a letter from Dr. F. Regel, dated May 20, 1897, from which it appears that he has completed his researches on the *paramos* lying east and south of Antioquia. All his collections and effects were already on the way to Europe, where he himself expected to arrive at latest by the middle of June. He mentions that he had visited the canal works at Panama, and observed how they were being slowly but steadily carried on. From 4000 to 5000, according to other accounts 8000, workmen are said to be employed, besides 2000 officials, and good work is being done, especially at the Panama entrance, and also at Culebra.

AUSTRALASIA AND OCEANIC ISLANDS.

Meteorological Observatory for Mount Kosciusko.—We learn from the *Brisbane Courier* that the amount necessary for the establishment of a tentative meteorological station on Mount Kosciusko has been generously promised by the Hon. R. Barr-Smith, of South Australia. It is hoped that low-level observations for comparison may be obtained from stations in the various Australian colonies, and that such results will be forthcoming as will lead to the establishment of a permanent station on the mountain.

Mr. Woodford's Report on the Solomon Islands—In his capacity of Acting Deputy Commissioner for the British Solomon Islands, Mr. C. M. Woodford last year made several tours of inspection through the group, and the results of his inquiries as to the prospects and resources of the islands are embodied in a Consular Report lately issued. Local trade is at present carried on with the aid of small vessels of from two to sixty tons, which collect the produce and convey it to central stations to await the periodical visits of Sydney vessels. At present eighteen trading firms or individuals have dealings with the Solomons, ten being British. Copra is the chief article of export, the islands presenting unequalled advantages for the growth of the coco-nut palm, and the trade would admit of large extension, especially if the system of drying were improved. The next article in importance is ivory-nut. The palm which produces it grows wild throughout the group in

inexhaustible quantity, and there seems a steady though not large demand for the produce. Pearl-shell (including a small quantity of the finest "gold-edged" variety), turtle-shell, and Bêche de mer complete the list as it stands at present. The Marau Company have lately acquired a tract of land on the north coast of Guadalcanar for agricultural experiments, and it is proposed to grow cacao, coffee, vanilla, and other products. Rubber may possibly prove a product worth exploiting, whilst sago might be manufactured from the pith of the ivory-nut palm. A valuable dark wood resembling ebony is found on New Georgia. Mr. Woodford recommends the small island of Tulagi, north of Guadalcanar, as a suitable site for a government residence.

POLAR REGIONS.

The Belgian Antarctic Expedition.—This expedition left Antwerp on August 16, on board the *Belgica*. Its commander, Lieut. de Gerlache, is supported by Lieuts. Lecointe and Danco, and by MM. Arctowski and Racovitza, as scientific members of his staff. The American scientist, Dr. Cook, will, it is said, join the expedition at Montevideo. It is proposed, after coaling at the Falkland islands or the straits of Magellan, to make for the land discovered by the *Jason* to the east of Graham's Land, and to advance as far as possible southwards into the George IV. sea. On the approach of winter, *i.e.* in about March, 1898, the *Belgica* is to make for Melbourne, and, after refitting, to spend some months cruising in the Pacific. During the next summer of the southern hemisphere the expedition hopes to proceed towards Victoria Land, and effect a new determination of the southern magnetic pole.

Light and Plant-growth in the Arctic Regions.—Prof. Wiesner, of Vienna, started for Advent bay, Spitsbergen, on July 18, in order to commence there a series of investigations into the climate of the arctic regions as affecting the growth of plants, with especial reference to their requirements in the matter of light. Similar investigations were made by him a few years ago in Egypt, India, and Java.

GENERAL.

Tozer's History of Ancient Geography.—The latest volume of the Cambridge Geographical Series* goes far to fill a serious gap in geographical literature. The need for a concise and interesting history of geography in English has often been expressed, and now, so far as the period covered by his work is concerned, Mr. Tozer has earned the thanks of all concerned in geographical education. A volume dealing with the whole range of time on the lines of M. Vivien St. Martin's 'Histoire de la Géographie,' would have been more welcome still, but we hope that the Cambridge Series will be enriched by other volumes similar to that before us dealing with more recent periods. Mr. Tozer follows Sir E. H. Bunbury's great 'History of Ancient Geography' somewhat closely, but his extensive personal knowledge of the Eastern Mediterranean and Asia-Minor enables him to import a living interest into the work, no chapter of which can fail to interest and most chapters will absolutely fascinate the reader. The book will not supersede Bunbury's monumental work, but rather serve as an introduction to it. In his introductory chapter, Mr. Tozer shows that he takes no narrow view of the scope or of the importance of geography. Beginning with the earliest Greek legendary geography, he treats in turn of the Homeric period, the growth of the

* 'A History of Ancient Geography.' By H. F. Tozer, M.A. Cambridge: The University Press. 1897.

Greek colonies, the speculations of Hecatæus, the history of Herodotus, the expeditions of Alexander and of Pytheas, the Roman conquests, the works of Strabo, Pliny, and Ptolemy. Interspersed with these are special chapters summarizing the progress amongst the Greeks of mathematical and physical geography, on Roman frontier defences and roads, and on the estimates of mountains in antiquity. No attempt is made to refer to all recent works on classical geography, although, to take one or two cases, it would not have appeared out of place to mention such essays as Dr. Schlichter's on the "Ptolemaic Lakes of Africa," Mr. Ryland's on the "Geography of Ptolemy" (whose theory as to the cause of Ptolemy's mistake in the orientation of Scotland might well have been mentioned), and Mr. Myres's on the "Maps of Herodotus." The footnotes in many cases suffer from the excessive conciseness of the references to authorities, some of which it might be rather difficult to trace.

Geological Bibliography.—Prof. E. De Margerie has produced, under the auspices of the International Geological Congress, a valuable list of geological bibliographies,* which is of considerable geographical importance as well. The plan of the work is based on the late M. James Jackson's list of special geographical bibliographies. No less than 3918 bibliographies are noted, comprising works of every size from a single leaf to many volumes, and dealing with every aspect of geology. The classification adopted shows the vast variety of the matter which had to be brought into shape, and suggests some of the difficulties with which the compiler had to grapple. The first division is into General and Regional Geology. The former includes five main subdivisions, viz. Histories and Bibliographies of Geology as a whole, arranged chronologically; Periodical Bibliographies, grouped according to subject and date; Personal Bibliographies, *i.e.* lists of the works of individual geologists; Subject Bibliographies, giving the titles of works on special departments of geology, arranged alphabetically according to subject; and General Geological Bibliographies, a list of the works giving references to the literature of the geology of the world or of Europe as a whole. The second part, Regional Geology, is first divided into as many groups as there are countries, lists of the geological writings on which have been compiled. These are arranged alphabetically according to the names of the countries in French, and each is subdivided into eight sections, similar on the whole to the subdivisions of the general part. The work was originally contributed by special correspondents in each of the most important countries represented; but the task of editing and bringing the whole into a uniform form was by no means facilitated by this division of labour. The result is one on which M. de Margerie may well congratulate himself, and he has laid all geological students under a great debt of gratitude.

The Directorship of the Vienna College of Meteorology.—Prof. Julius Hann has, at his own request, been relieved of the post of director of the "Centralanstalt für Meteorologie und Erdmagnetismus," which he held in conjunction with that of Professor of Terrestrial Physics at the University of Vienna, and has been appointed Professor of Meteorology at Gratz, in Styria. Born in 1839 at Linz, in Upper Austria, Prof. Hann has for the last twenty years—ever since the death of Jelinek—been at the head of the Vienna College of Meteorology, and has by the force of his personality won for it the international recognition which it has attained by reason of its important services to meteorology and climatology. The

* 'Catalogue des Bibliographies Géologiques, rédigés avec le concours des membres de la commission bibliographique du Congrès.' Par Emm. de Margerie. Paris: Gauthier Villars et Fils. 1896.

vacant place has been filled by the summons to Vienna, from the University of Innspruck, of Prof. Joseph Pernter, who was born in 1848 at Neumarkt, in the Tirol. The new director is, after Prof. Hann, the best authority on meteorology in Austria. He has lately issued a work bearing the title 'Das Wetter,' which is a free translation of the English work of the Hon. Ralph Abercromby.

OBITUARY.

Captain Bertram Lutley Sclater, R.E.

It is with much regret that we record the death, from fever at Zanzibar, at the early age of thirty-one years, of Captain B. L. Sclater, whose name has frequently been before our readers during the past few years for his excellent pioneer work in the British Protectorates in East and Central Africa. The deceased officer, who joined our Society in 1891, was the second son of the well-known zoologist, Mr. P. L. Sclater, and was educated at Wellington College and at the Royal Academy, Woolwich. He became lieutenant in the Royal Engineers in 1885, and captain in 1895. On the appointment of Mr. (now Sir Harry) Johnston as Commissioner in British Central Africa in 1891, Captain Sclater was placed on his staff, with a view to the execution of an authoritative survey of Nyasaland. During his two years' stay in the country, he not only carried out this task, but materially aided in the opening up of the country by the construction of roads. He also took part in the military expeditions against the slave-raiding chiefs, receiving the Central African war medal in 1895 in recognition of his services. The general results of his work and observations in Nyasaland were put before our Society in a paper published in the second volume of the *Journal*. In 1895 he was sent to the East Africa Protectorate, entrusted with the task of constructing a road, suitable for wheeled traffic, from Mombasa to the Victoria Nyanza. We have from time to time given details respecting the progress of this important work, which was successfully completed towards the end of last year. Captain Sclater was lately commissioned to convey a steamer in sections along this road to the Victoria Nyanza, but before advancing far he was attacked by fever so severely that he was compelled to return to Zanzibar, where he proved unable to shake off the insidious malady. Captain Sclater received the Cuthbert Peek Grant of our Society in 1891.

Samuel E. Peal, Esq.

The death has been announced of Mr. Samuel Peal, who, during a lengthened residence in Assam, did much to add to our knowledge of the imperfectly known districts and wild tribes bordering on that province. Many of his papers have appeared in the *Journal of the Asiatic Society of Bengal*, and other scientific periodicals. One of the most important, from a geographical point of view, was that in which he described (*J.A.S.B.*, vol. l. part 2, No. 1) a journey undertaken in 1879 to the Nongyang lake on the Burmese frontier, during which he studied the question of the best pass over the Patkoi range. Others of his papers deal with points connected with the ethnology of the Nagas and other hill tribes bordering on Assam. Mr. Peal joined our Society in 1879, and in 1889 contributed to the *Proceedings* a short paper on "River Names in Farther India."

CORRESPONDENCE.

Aide-memoire to a Comparison of Certain Geographical Distances.

BELIEVING that it is more important to avoid ignorance than to acquire knowledge, and that it is better to be never very far wrong than perhaps absolutely right or hopelessly incorrect, it appeared to me that the following coincidences which I have arranged, and which I have found of some personal assistance in the study of geography, may be of interest.

One is accustomed to see maps of continents on small scales and of islands on large, and thus one's ideas of distance are apt to vary according to the size of the country under consideration. A tailor can, from a few salient measurements, realize the exact dimensions involved in constructing a coat, and by remembering the shape of a particular country and the distances between certain known places or features, an approximate idea may be formed of the distance between any two places whose locality is known, or extent of any known region therein. By taking a *fixed unit* of distance and remembering merely the places to which this unit corresponds, the effort of memory is considerably simplified.

I happened to select as the unit, the length of the British Isles, *i.e.* Land's End to the Hebrides (750 miles), and have been extremely surprised at the remarkable number of salient distances to which this unit corresponds. I have found similar results unattainable with any other standard of measurement.

It appears to represent the natural extent of most of the homogeneous countries and of a great many geographical features, as well as the distance at which rival centres of government or important towns have sprung into existence. I have found the system useful as giving an idea of distance in the following amongst many instances, *e.g.* Napoleon's march to Moscow, 1500 miles, of which half was through a hostile country; also as enabling the distances involved in the Russian reinforcement of the Crimea, Turkestan campaigns, and in our own frontier questions in India, Burmah, Egypt, and South and West Africa, to be estimated and compared.

Many more examples might be given, but it is hoped that a recollection of any of them that may strike the fancy may prove useful.

Standard—Land's End to Shetland Islands, distance 750 miles.

EUROPE.

Geographical Features.

Length of Black sea (maximum).
„ Caucasus.
„ Caspian sea (maximum).
Length of Mediterranean—
East coast of Mediterranean to Cape Matapan.
Cape Matapan (Greece) to Cape Spartivento.
Cape Spartivento (Sardinia) to Gibraltar.
Adriatic to Bay of Biscay (Trieste to Bayonne).
Cape Finisterre to Straits of Dover.
Shetland islands to North cape (Iceland).
North to south length of Baltic (Tornea to Memel).
Black sea to Baltic (Memel).
*Baltic to Adriatic (Memel to Trieste).
*Trieste to Cape Matapan.
*Cape Matapan to mouth of Danube.
*Mouth of Danube to Trieste.

* N.B.—These form a diamond of two equilateral triangles.

Countries.

Length of Spain and Portugal (Cape St. Vincent to Cape Creux).
Length of Switzerland and France.
„ Italy and Sicily.
„ Austria (east and west).
Length of Germany (Memel to Treves).
„ Turkey (Bosphorus to North-West Bosnia).
Length of British Isles (Land's End to Shetlands).

Distances between Capital Towns.

London to Christiania.
„ Madrid (approximate).
„ Florence.
„ Venice.
„ Vienna, Vienna to Constantinople; hence London to Constantinople, 1500 miles.
Vienna to Stockholm.
Rome to Berlin.
„ Brussels.
Copenhagen to Dublin.
Copenhagen to St. Petersburg.
Moscow to Stockholm.
„ Odessa, Moscow to mouth of river Mezen (North sea); north and south length of Russia = 1500 miles.
Moscow to Orenburg, Moscow to Warsaw—east and west breadth of Russia in Europe = 1500 miles.
Moscow to Warsaw, Warsaw to Rheims—Napoleon's expedition, 1812.

ASIA.

Length of Red sea—Suez to Jeddah, Jeddah to Aden.
Breadth of Arabia—Jeddah to Persian gulf.
Persian gulf to Mediterranean.
Caspian to Mediterranean.
Caspian to Straits of Ormuz (entrance to Persian gulf).
Caspian to Kandahar.
East to west breadth of Persia (to head of Persian gulf).
Eastern frontier of Persia.
North to south length of Afghanistan and Baluchistan.
Orenburg to Tashkend.
Tashkend to Rawal Pindi.
Eastern frontier of India—Rawal Pindi to Allahabad, Allahabad to Manipur.
Length of western frontier of India.
West coast of India—Karachi to Goa, Goa to Point de Galle.
Eastern coast of India—
Point de Galle to Masulipatam.
Masulipatam to Calcutta.
Surat to Himalayas.
Bombay to Lucknow.
Bombay to bay of Bengal (east to west).
Calcutta to river Yang-tse-kiang.
Calcutta to Chinese frontier (east to west), Chinese frontier (as above) to Hong Kong—Calcutta to Hong Kong 1500 miles.
North to south length of Burmah.
Bay of Bengal to gulf of Tonquin (through Aracan).
Cochin China to Phillipine isles (east to west).
Canton to mouth of Yang-tse-kiang (Shanghai).
Ningpo to Pechili.
Pechili to Japan.
Length of Niphon (Japan).

AFRICA.

Gibraltar to Madeira.
Coast of Algeria.
Coast of Morocco.
South to east and south to west length of Morocco.
Mean breadth of Sahara desert (north to south).
Length of Guinea (north to south).
Sierra Leone to St. Jago (Cape de Verde islands).
Timbuctoo to Kumasi.
Sierra Leone to Kumasi.
Kumasi to Cameroons.
Cameroons to mouth of river Congo.
North to south length of Congo State (mean).

Coast of Anzola and Benguela.
Length of Namaqualand, north to south.
Cape Town to Natal (straight line).
Length of Cape Colony (north frontier line).
Length of South African Republic and Orange River Free State.
North Madagascar to Mauritius.
North Madagascar to Zanzibar.
South Madagascar to Delagoa bay.
Ulundi to mouth of Zambesi.
Mouth of Zambesi to Victoria falls.
Victoria falls to Tanganyika.
Victoria falls to Walfish bay.
Victoria falls to Kimberley (Orange river).
Kimberley to Walfish bay.
Cape Town to Mafeking.
Cairo to Dongola.
East-west breadth of Egypt (at Wady Halfa).
White Nile to Zeylah (west to east).
Northern boundary of Somaliland.

AMERICA.

Mount Hecla (Iceland) to Cape Farewell (Greenland).
Cape Farewell to Resolution island (Hudson straits).
Cape Farewell to Cape Charles (South Labrador).
East to west breadth of Greenland (through Jacobshavn).
Length of coast-line of Labrador.
Mouth of St. Lawrence to Quebec.
North to south length of Hudson bay to Cape Wolstenholme.
Detroit to south of Hudson bay.
" Montreal.
" New York.
Detroit to Charleston.
New York to Charleston.
South of Lake Winnipeg to Rocky mountains.
South of Lake Winnipeg to south of Hudson bay.
South of Lake Winnipeg to Chicago.
Bermuda to Cape Hatteras.
Cape Hatteras to South Florida.
Mean north to west breadth of Alaska.
Length of California.
" Cuba.
East to west breadth of Ecuador.
" " Peru.
" " Bolivia.

AUSTRALIA.

Mean breadth of Queensland (east to west).
Mean breadth of New South Wales.
Mean breadth of South Australia.
Coast-line of New South Wales.

F. J. S. CLEEVE,
Captain R.A.

Prof. Copeland's Revised Map of Franz Josef Land.

I notice in the August issue of the *Geographical Journal* an important and most interesting article by Prof. Copeland. In this article Mr. Copeland endeavours, as Payer's friend, to revise the latter's original map of Franz Josef Land in the light of recent discoveries, and at the same time to retain as much as he possibly can of the *status quo ante*. That is chivalrous; still, in the absence of my friend Mr. Jackson, and pending his return to the inhabited world, I must enter a protest against the attempt to rehabilitate Richthofen peak. For in spite of the fact that Jackson has camped in perfectly clear weather on the spot where Richthofen peak was stated by Payer to rise some 5000 feet above the sea, and that Jackson has seen nothing whatever resembling it (the highest point within some miles being a cape some 700 feet high), Prof. Copeland thinks that Richthofen peak still exists and is approximately of the same dimensions and in the same locality as defined by Payer.

Prof. Copeland writes (*Geog. Jour.*, August, 1897, p. 186): "From these considerations, it seems very probable that Richthofen peak is to be looked for at no considerable distance from the point indicated on the map, and that its height does not differ greatly from 4000 feet."

According to Prof. Copeland, Payer estimated the distance of this peak, when he saw and described it, to be about 60 nautical miles* distant from his point of observation. Now let us see what Jackson, who has twice camped in the very locality allotted to Cape Richthofen, says about it. I turn first to my paper in the *Geog. Jour.*, December, 1895, p. 518—for even then it had been discovered that Richthofen peak was not to be found where the map placed it: "Mr. Jackson camped within a mile of the spot in clear weather, and he states there is not a mountain to be seen, or anything approaching to one, north, south, east, and west, in that locality."

Not far away, however, was a cape, about 700 feet high, and in the following year, in remarkably clear weather, Jackson ascended this cape and sketched and photographed the surrounding locality (see *Geog. Jour.*, December, 1896, p. 552). As this was the nearest approach to the Richthofen peak of Payer, Jackson named the headland Richthofen cape.

This is what he says in one of his 1896 letters: "The cape upon which we got this view" (a view unobstructed by fog in any direction) "is the one in Payer's map upon which his Richthofen peak stands (which does not exist at all, as I told you last year)."

Now, Prof. Copeland would have us believe that what Payer saw at the distance of 60 geographical miles is fact; and that, consequently, what Jackson saw, *when on the very spot in question*, is fiction. At least so it would appear to me. Any one acquainted with arctic travel, or its abounding and deeply interesting literature, knows that it is extremely easy to mistake cloud and fog-banks for distant land. And this would seem to be the solution of Prof. Copeland's difficulty. Indeed, in the professor's contribution to the *Geographical Journal* of this month, I find that he provides this very solution (see *Geog. Jour.*, August, 1897, p. 189): "The greatest error in the original map is the north-eastern part, where Payer shows the large Dove glacier extending far to the north, in place of the open sea with a solitary group of islands which Nansen found in that region. There seems little doubt that Payer on his northward journey mistook fog-banks on the eastward horizon—possibly in combination with the ice-hummocks, which would naturally be found on the margin of the fiord ice—for an extension of Wilczek Land towards the north beyond the latitude of 81° 5′. This mistake is the more pardonable," etc.

This explanation of Payer's apologist might reasonably, I think, be extended from the glacier to the peak. For if Payer could lay down a glacier of vast extent where no such glacier existed, and when within *twenty* miles of its supposed position, how much more easily could he establish a mountain where no mountain stands, when *sixty* miles distant from its reputed locality?

To the outsider, of course, the probabilities admit of no comparison. *The man on the spot* knows more about that spot than the man whose nearest approach to it is 60 miles away.

ARTHUR MONTEFIORE BRICE,
Hon. Sec. Jackson-Harmsworth Expedition.

157, Strand, W.C., August 9, 1897.

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* This is Prof. Copeland's statement. I make the distance less, both in Payer's original and Prof. Copeland's revise.

GEOGRAPHICAL LITERATURE OF THE MONTH.

Additions to the Library.

By HUGH ROBERT MILL, D.Sc., *Librarian*, R.G.S.

THE following abbreviations of nouns and the adjectives derived from them are employed to indicate the source of articles from other publications. Geographical names are in each case written in full:—

A. = Academy, Academie, Akademie.
Ann. = Annals, Annales, Annalen.
B. = Bulletin, Bollettino, Boletim.
Com. = Commerce, Commercial.
C. Rd. = Comptes Rendus.
Erdk. = Erdkunde.
G. = Geography, Geographie, Geografia.
Ges. = Gesellschaft.
I. = Institute, Institution.
J. = Journal.
M. = Mitteilungen.
Mag. = Magazine.
P. = Proceedings.
R. = Royal.
Rev. = Review, Revue, Revista.
S. = Society, Société, Selskab.
Sitzb. = Sitzungsbericht.
T. = Transactions.
V. = Verein.
Verh. = Verhandlungen.
W. = Wissenschaft, and compounds.
Z. = Zeitschrift.

On account of the ambiguity of the words *octavo*, *quarto*, etc., the size of books in the list below is denoted by the length and breadth of the cover in inches to the nearest half-inch. The size of the *Journal* is 10 × 6½.

EUROPE.

Austria—Bohemia. **Bourlier.**
Bibliothèque d'Histoire contemporaine. Les Tchèques et la Bohême Contemporaine. Essai d'histoire et de politique. Par Jean Bourlier. Paris: J. Alcan, 1897. Size 7½ × 5, pp. x. and 266. *Price* 2*s.* 6*d.*
A sketch of the history of Bohemia and of the present position of Bohemian affairs.

Belgium and Holland. **Baedeker.**
Belgium and Holland including the Grand Duchy of Luxembourg. Handbook for Travellers by K. Baedeker. With 14 Maps and 21 Plans. Twelfth Edition. Leipsic: Karl Baedeker; London: Dulau & Co. 1897. Size 6½ × 4½, pp. lxii. and 418. *Price* 6*s.* *Presented by Messrs. Dulau & Co.*
This excellent guide is too well known to require more than the recognition of a new edition.

France. *Rev. Scientifique* (4) **7** (1897): 648–654. **Mortillet.**
Les Écritures de France. Par M. G. de Mortillet. *With Illustrations.*
On prehistoric and historic inscriptions in France.

Germany. *Meteorolog. Z.* **14** (1897): 161–170. **Schwalbe.**
Ueber die Häufigkeit der Frost-, Eis- und Sommertage in Nord-Deutschland. Von Dr. G. Schwalbe.

Germany—Aschaffenburg. *Notizblatt Ver. Erdk. Darmstadt* (1896): 10–16. **Klemm.**
Ueber ein typisches Lössprofil bei Aschaffenburg. Von G. Klemm. *With Plate.*
On a typical section of the loess.

Germany—Hesse.
Mittheilungen der Grossherzoglich Hessischen Centralstelle für die Landesstatistik. 26 Band.—Notizblatt des Vereins für Erdkunde . . . zu Darmstadt. IV. Folge, 17 Heft, pp. viii. and 368. *Diagram.* Darmstadt, 1896. Size 9 × 6.

Greece. **Hartl.**
Meteorologische und Magnetische Beobachtungen in Griechenland. Ausgeführt von Heinrich Hartl. 2. Bericht. Separat-Abdruck aus den 'Mittheilungen des K. u. K. militär-geographischen Institutes,' xvi. Band. Wien, 1897. Size 9½ × 6½, pp. 32. *Map.* *Presented by the Author.*

Greece—Thessaly. *G.Z.* **3** (1897): 305–315. **Philippson.**
Thessalien. Von Dr. Alfred Philippson.
Touches upon all aspects of the geography of Thessaly.

Italy. *G.Z.* **3** (1897): 326–333. **Fischer.**
Die wichtigsten Grundlagen einer wissenschaftlichen Landeskunde von Italien. Von Theobald Fischer.
On the existing maps of Italy as a basis for geographical description.

Italy. **Marinelli.**

Area dell' Italia naturale. Comunicazione del Dott. Olinto Marinelli.—Atti del II° Congresso Geografico Italiano, Roma 1895. Roma, 1896. Pp. 153–158.

ASIA.

Asia Minor. *Quarterly Rev.* **186** (1897): 64–87. ———

Asia Minor rediscovered.

A general account of recent archæological research in Asia Minor.

Central Asia. *Globus* **71** (1897): 365–366. **Palleske.**

Sven Hedin's Rückkehr von seiner Forschungsreise durch Mittelasien. Von R. Palleske.

China. *B.S.G. Commerc. Havre* **14** (1897): 1–48. **Lièvre.**

Sur les Côtes de Chine. Par M. D. Lièvre. *With Illustrations.*

Notes on Hongkong, Amoy, Fuchau, Ningpo, the Saddle Islands, Shanghai, Kiaochau, Wei-hai-Wei, and Chefu.

China—Manchuria. **Pozdneyeff.**

Opisanie Manchurii. (D. Pozdneyeff.) 2 vols. St. Petersburg, 1897. Size 11 × 7½, pp. (vol. i.) vi. and 620; (vol. ii.) vi. and [288]. *Map. Presented by M. Venukoff.*

Historical. **Bittner and Tomaschek.**

Die topographischen Capitel des Indischen Seespiegels Mohît übersetzt von Dr. Maximilian Bittner, mit einer Einleitung sowie mit 30 tafeln versehen von Dr. Wilhelm Tomaschek. Festschrift zur Erinnerung an die Eröffnung des Seeweges nach Ostindien durch Vasco Da Gama (1497), herausgegeben von der K. K. Geographischen Gesellschaft in Wien. Wien, 1897. Size 17 × 11, pp. vi. and 92.

A translation of the 'Mohit or Mirror of the Indian Sea,' written by the Turkish Admiral, Sidi Ali, in 1554, with reconstructions of the Turkish maps of that period.

India—Assam. *J. Asiatic S. Bengal* **65** (Pt. 3) (1897): 9–17. **Peal.**

Eastern Nagas of the Tirap and Namtsik. By S. E. Peal. *With Plate.*

Refers to the rapid change in costume and customs going on amongst the aboriginal tribes.

India—Baluchistan. *P.I. Civil Engineers* **128** (1897): 232–256. **Ramsay.**

The Mushkaf-Bolan Railway, Baluchistan, India. By James Ramsay.

India—Burma. *Mem. S.G. Italiana* **6** (1897): 241–285. **Bertacchi.**

La Birmania e il viaggio di Leonardo Fea, nota del consigliere Prof. Cosimo Bertacchi.

India—Travancore. *P.I. Civil Engineers* **128** (1897): 140–205. **Pennycuick and Allen.**

The Diversion of the Periyar. By Colonel J. Pennycuick. (7 *Cuts.*)
The Periyar Tunnel. By P. R. Allen. (6 *Cuts.*)
Discussion on the Diversion of the Periyar, and on the Periyar Tunnel. (1 *Cut.*)
Correspondence on ditto. (1 *Cut.*)

Full particulars of the great engineering feat referred to in the *Journal*, vol. vi. 1895, p. 566, with numerous diagrams.

Malay Archipelago. *Ann. Hydrographie* **25** (1897): 208–214. ———

Makassar-Strasse. Balabalagan- oder Kleine Paternoster-Inseln. Nach einem Berichte des holländischen Vermessungsfahrzeuges "Banda." *With Chart.*

Ma'ay Archipelago—Cagayan Sulu. **Skertchly.**
J. Asiatic S. Bengal **65** (Pt. 3) (1897): 47–57.

Cagayan Sulu, its Customs, Legends, and Superstitions. By Ethelbert Forbes Skertchly.

A note will be given on this article.

AFRICA.

British Central Africa. **Johnston.**

British Central Africa. An attempt to give some account of a portion of the Territories under British Influence North of the Zambezi. By Sir Harry H. Johnston, K.C.B. With six Maps and 220 Illustrations. London: Methuen & Co., 1897. Size 10½ × 7½, pp. xx. and 544. *Price* 30*s. Presented by the Publishers.*

This valuable work will be specially noticed.

British East Africa—Zanzibar. *Oesterr. Monats. Orient* **23** (1897): 37–41. ——

Die Abschaffung der Sclaverei auf Zanzibar.

British South Africa. **Baden-Powell.**

The Matabele Campaign, 1896. Being a Narrative of the Campaign in suppressing the Native Rising in Matabeleland and Mashonaland. By Colonel R. S. S. Baden-Powell. London: Methuen & Co., 1897. Size 9 × 6, pp. xvi. and 500. *Sketch-map and Illustrations. Price* 15*s*. *Presented by the Publishers.*

In his dedication Colonel Baden-Powell explains that this book is merely an illustrated diary of a sketchy and incomplete character, kept mainly in order to share his impressions with his friends at home. The result is that the descriptions and sketches are extremely vivid and interesting, and many glimpses of the character of the country show how valuable a detailed geographical survey will be when the conditions of the country make such work practicable.

Cape Colony—Basutoland. *B.S. Neuchateloise G.* **9** (1897): 107–151. **Jacottet.**

Mœurs, coutumes et superstitions des Ba-Souto. Par E. Jacottet.

Congo State. *Mouvement G.* **14** (1897): 133–141, 157–162, 169–175, 205–208. **Brasseur.**

L'Urua, pays des Balubas. Historique de la découverte. Description du pays. Reconnaissance du Lualaba (Kamoloudo) et du Luapula (Luvua) par le lieutenant Clément Brasseur. *With Maps, Portraits, and Illustrations.*

East Africa—Obok. *J.R. United Service I.* **41** (1897): 623–630. **Fedoroff.**

Obok and the Country bordering on the Gulf of Tajura. Translated from the Russian of V. Fedoroff by Lieut.-Colonel W. E. Gowan (retired). *With Map.*

East Africa—Somaliland. **Elliot.**

Field Columbian Museum. Publication 17. Ornithological Series, vol. i. No. 2. Catalogue of a Collection of Birds obtained by the Expedition into Somaliland. By D. G. Elliot. Chicago, 1897. Size 10 × 6½, pp. 27–68.

East Africa—Somaliland. *Mem. S.G. Italiana* **6** (1897): 290–311. **Millosevich.**

Discussione delle osservazioni astronomiche, fatte fra Lugh e Sancurà dal tenente L. Vannutelli addetto alle seconda spedizione Bòttego, nota del consigliere prof. Elia Millosevich.

Observations for latitude and longitude on Bòttego's expedition, with lists of positions determined.

Egypt. *Rev. G. Int.* **22** (1897): 31–35, 57–60. **Duysters.**

Impressions d'Égypte. Par Edmond Duysters. *With Illustrations.*

Egypt. **Mayou.**

Les Temples de la Géographie dans l'Égypte Antique. Par L. Mayou. [From *L'Initiation*, 35e volume, 10me Année, No. 7 (Avril, 1897).] Paris. Size 8 × 5½, pp. 32–41. *Presented by the Author.*

Egypt and Abyssinia. *Riv. G. Italiana* **4** (1897): 65–79. **Reinisch.**

Uno squardo sull' Egitto e l'Abissinia. Dal Prof. Leo Reinisch.

Translation of an inaugural address at the University of Vienna. (Cf. *Journal*, vol. ix. p. 314.)

Egypt—Dongola. *J.R. United Service I.* **41** (1897): 669–689. **Atteridge.**

The Dongola Expedition of 1896. By Captain A. Hilliard Atteridge. *With Maps.*

Eritrea. **Franchetti.**

L'avvenire della Colonia Eritrea. Conferenza dell' on. Leopoldo Franchetti.—Atti del IIo Congresso Geografico Italiano, Roma 1895. Roma, 1896. Pp. 23–44.

NORTH AMERICA.

Bermuda Islands. **Tarr.**

Changes of Level in Bermuda Islands. By Ralph S. Tarr. [From *the American Geologist*, vol. xix., May, 1897.] Size 9½ × 6½, pp. [12]. *Plates.*

Canada—Forest Trees. *Scottish G. Mag.* **13** (1897): 281–296. **Bell.**

The Geographical Distribution of Forest Trees in Canada. By Dr. Robert Bell. *With Illustrations.*

Canada—Saskatchewan. *B.S. Neuchateloise G.* **9** (1897): 89–106. **Petitot.**
Du lac de l' Isle-à-la-Crosse au Fort Carlton (Basse-Saskatchewan). Par Émil Petitot.

Mexico—Yucatan. **Millspaugh.**
Field Columbian Museum. Publication 15. Botanical Series. Vol. i., No. 3. Contribution II. to the Coastal and Plain Flora of Yucatan. By Charles Frederick Millspaugh, M.D. Chicago: December, 1896. Size 10 × 6½, pp. 277–340. *Map and Plates. Presented by the Museum.*

United States—California. **Muir.**
The Mountains of California. By John Muir. London: T. Fisher Unwin, 1894. Size 8 × 5½, pp. xiv. and 382. *Maps and Illustrations. Price 7s. 6d. Presented by the Publisher.*

CENTRAL AND SOUTH AMERICA.

Amazon. *B.S.G. Commerc. Bordeaux* **20** (1897): 220–226. **Carbajal.**
Navigabilité de l'Amazone. Par Meliton Carbajal. (Traduit par Carlos B. Cisneros.)

Argentine Coast. *Ann. Hydrographie* **25** (1897): 182–190. **Knipping.**
Das Wetter zwischen dem La Plata und Kap Horn im Juli, 1890. Von E. Knipping. *With Charts.*

Bolivia. **Baldivieso.**
Informe que presenta al Señor Ministro de Colonización el Intendente de la Delegación Nacional en el Noroeste teniente coronel Pastor Baldivieso, Bolivia, Riberalta. La Paz, 1896. Size 11 × 7, pp. 80.

Brazil. *Petermanns M.* **43** (1897): 59–68, 107–112. **Goeldi.**
Eine Naturforscherfahrt nach dem Litoral des südlichen Guyana zwischen Oyapock und Amazonenstrom (Oktober und November, 1895). Von Dr. Emil A. Goeldi.

Brazil—Geology. **Grossi.**
Sui progressi degli studi intorno alla Geologia e Mineralogia del Brasile. Comunicazione del Prof. Vincenzo Grossi.—Atti del II° Congresso Geografico Italiano, Roma, 1895. Roma, 1896. Pp. 228–236.

Brazil—Xingu. *B.S. Neuchateloise G.* **9** (1897): 152–158. **Philippin.**
Le Xingú paraense. Explorations d'Henri Coudreau. Traduction inédite du portugais. Par C.-A. Philippin.

AUSTRALASIA.

Australasia. **Coghlan.**
A Statistical Account of the Seven Colonies of Australasia, 1895–6, by T. A. Coghlan. Sixth Issue. Sydney: C. Potter, 1896. Size 9 × 6, pp. xvi. and 502. *Map. Presented by the Agent-General for New South Wales.*

Australia—Marine Commercial Products. **Saville-Kent.**
Scottish G. Mag. **13** (1897): 296–308.
The Market Fishes and Marine Commercial Products of Australia. By W. Saville-Kent.

Australia—Year-Book. **Greville.**
The Year-Book of Australia for 1897. Edited by the Hon. Edward Greville. London: Paul & Co. Size 9 × 6, pp. 724. *Maps. Presented by the Agent-General for New South Wales.*

British Solomon Islands. **Woodford.**
Colonial Reports.—Miscellaneous. No. 8. Western Pacific. Report on the British Solomon Islands. By Mr. C. M. Woodford. London: Eyre and Spottiswoode, 1897. Size 10 × 6½, pp. 34. *Map. Price 4½d.*
Noticed in the Monthly Record, *ante*, p. 330.

Dutch New Guinea. **Horst.**
Tijds. K. Ned. Aardrijks. Genoots. Amsterdam (2) **14** (1897): 124–131.
Nieuws van de Jakati-rivier. Door Dr. D. W. Horst. *With Sketch-Map.*

POLAR REGIONS.

Antarctic. **Arctowski.**
Observations sur l'intérêt que présente l'exploration géologique des terres australes. Par H. Arctowski. (Extrait du Bulletin de la Société Géologique de France, 3° série, t. xxiii., pp. 589–592, année 1895.) Size 10 × 6½. *Presented by the Author.*

Antarctic. **Wegener.**

Der Südpol. Die Südpolarforschung und die deutsche Südpolar-Expedition. Von Dr. Georg Wegener. Berlin: H. Paetel, 1897. Size 8½ × 6, pp. 66. *Maps. Price* 1*s.* 6*d. Presented by the Publishers.*

Dr. Wegener gives an historical sketch of antarctic exploration, with an outline of the plan of the proposed German expedition. There is an excellent map of the south polar region showing the routes of expeditions.

Antarctic Drift Ice. *Ann. Hydrographie* **25** (1897): 190–199. **Dinklage.**

Treibeis im Süden vom Kap der Guten Hoffnung und im Indischen Ocean. Von L. E. Dinklage.

Greenland. **Tarr.**

Valley Glaciers of the Upper Nugsuak Peninsula, Greenland. By Ralph S. Tarr. [From the *American Geologist*, vol. xix., April, 1897.] Size 9½ × 6½, pp. [8]. *Plate.*

Greenland—Cornell Glacier. *B. Geolog. S. America* **8** (1897): 251–268. **Tarr.**

Former extension of Cornell Glacier near the Southern end of Melville Bay. By Ralph S. Tarr. *With Map and Plates.*

Norwegian Arctic Expedition. **Nansen.**

Some Results of the Norwegian Arctic Expedition, 1893–96. By Fridtjof Nansen, D.SC.; and the North Polar Problem. From the *Geographical Journal* for May, 1897. Size 10 × 6½, pp. 56. *Maps and Illustrations.*

Polar Ice. *Ann. Hydrographie* **25** (1897): 215–218. ———

Ueber die Resultate der magnetischen und hydrographischen Beobachtungen im Eismeere in den Jahren 1893 bis 1895.

PHYSICAL AND BIOLOGICAL GEOGRAPHY.

Geomorphology. *Mem. S.G. Italiana* **6** (1897): 342–377. **Porena.**

Delta Morfologia della superficie terrestre e dei tipi di rilievo con la loro nomenclatura in italiano, memoria del socio Prof. T. Porena.

A careful review of the views on geomorphology held by the leading exponents of that branch of physical geography.

Limnology. **Marinelli.**

Sull' opportunità di stabilire una classificazione generale e una relativa nomenclatura dei laghi basata prevalentemente su criteri geografici. Relazione del dottore Olinto Marinelli.—Atti del II° Congresso Geografico Italiano, Roma, 1895. Roma, 1896. Pp. 213–220.

Limnology. *B.S. Neuchateloise G.* **9** (1897): 165–181. **Pitard.**

Sur la répartition des organismes inférieurs à la surface de quelques lacs suisses. Par Eugène Pitard.

Limnology—Seiches. *C. Rd.* **124** (1897): 1074–1076. **Forel.**

Seiches des lacs et ouragan-cyclone. Note de M. F. A. Forel.

A special note will appear on this paper.

Mountain-winds. **Marinelli.**

Breve contributo allo studio delle brezze di monte. Comunicazione del dott. Olinto Marinelli.—Atti del II° Congresso Geografico Italiano, Roma, 1895. Roma, 1896. Pp. 200–204.

Oceanography. **Cassanello.**

Dei lavori idrografici e talassografici compiuti sotto gli auspici del R. Ufficio Idrografico Italiano, Conferenzo del Comandante Gaetano Cassanello.—Atti II° Congresso Geografico Italiano, Roma, 1895. Roma, 1896. Pp. 67–110.

Oceanography—Atlantic. *B.S.G. Commerc. Bordeaux* **20** (1897): 212–215. **Hautreux.**

De Terre-Neuve à la côte des Landes. Trajet d'une bouteille flottante. Par A. Hautreux.

Account of a bottle voyage; the bottle was thrown over in 45° N. 51° W. on September 27, 1895, and picked up on the French coast in 45° 16′ N. The distance of 2100 sea miles was traversed in 507 days. The peculiar circumstance is that its ultimate direction was due east, escaping the Gulf Stream drift.

BIOGRAPHY.

Bielz. *Deutsche Rundschau G.* **19** (1897): 326–328. ———

Dr. Edward Albert Bielz. *With Portrait.*

Dr. Bielz has done much for the furtherance of geographical education in Transylvania, and has also studied and described the physical, and especially the biological, geography of the province.

Biographical Dictionary. **Lee.**

Dictionary of National Biography. Edited by Sidney Lee. Vol. xlix. Robinson—Russell; vol. l. Russen—Scobell. London: Smith, Elder & Co., 1897. Size 10 × 7, pp. (vol. xlix.) vi. and 496; (vol. l.) vi. and 456. *Price of each volume*, 15*s.*

Vol. xlix. includes notices of the following names of geographical interest: John Septimus Roe, by B. B. Woodward; Sir Thomas Roe, by Stanley Lane-Poole; Hugh Hastings Romilly, by C. Alexander Harris; Alexander Ross, by G. Le Grys Norgate; Sir James Clark Ross, by Prof. J. K. Laughton; and Sir John Ross, by the same. Vol. l.: Sir Edward Sabine, by Colonel R. H. Vetch, C.B.; James Augustus St. John, by J. R. Macdonald; Sir Oliver Beauchamp Coventry St. John, by Colonel R. H. Vetch; Thomas Salmon, by Thompson Cooper; Henry Salt, by Warwick Wroth; Christopher Saxton, by Lionel Cust; and Sir Robert Hermann Schomburgk, by G. C. Boase.

Cope. *American Naturalist* **31** (1897): 410–419. **Frazer and Kingsley.**

In Memoriam E. D. Cope. By Persifor Frazer. Obituary Notice of E. D. Cope. By J. S. Kingsley. *With Portraits.*

Downing. *Nautical Mag.* **66** (1897): 375–376. ———

The Editor's Album: Dr. Arthur M. W. Downing, M.A., F.R.S., Superintendent of the "Nautical Almanac" Office. *With Portrait.*

Du Pasquier. *G.Z.* **3** (1897): 343–344. **Penck.**

Léon Du Pasquier. Von Prof. Dr. Albrecht Penck.

Gould. *Deutsche Rundschau G.* **19** (1897): 375–376. ———

Benjamin Apthorp Gould. *With Portrait.*

Negri. **Marinelli.**

Accademia Reale delle Scienze di Torino (Anno 1896–97). Cristoforo Negri, Commemorazione letta il 28 febbraio 1897 davanti la R. Accademia delle Scienze di Torino dal Socio Corrispondente Giovanni Marinelli. Torino: Carlo Clausen, 1897. Size 12½ × 9, pp. 26. *Portrait.*

Sverdrup. *Deutsche Rundschau G.* **19** (1897): 373–374. ———

Capitän Otto N. Sverdrup. *With Portrait.*

Tisserand. *Deutsche Rundschau G.* **19** (1897): 328–330. ———

Felix Tisserand. *With Portrait.*

The director of the Paris Observatory. Born 1845, died 1896.

GENERAL.

Ballooning. *Meteorolog. Z.* **14** (1897): 121–143. **Hergesell.**

Die Ergebnisse der ersten internationalen Ballonfahrt in der Nacht vom 13 zum 14 November 1896. Von H. Hergesell.

Die zweite internationale Ballonfahrt am 18 Februar 1897. Vorläufiger Bericht von H. Hergesell.

Ballooning. *C.Rd.* **124** (1897): 1180–1182. **Hermite and Besançon.**

Sur les trois ascensions françaises de la troisième expérience internationale. Note de MM. Hermite et Besançon.

Ballooning. *Rev. Scientifique* **7** (1897): 545–552. **Pesce.**

La navigation aérhydrique et les perfectionnements à introduire dans la construction des aérostats. Par M. G.-L. Pesce.

The author draws a just parallel between the problems of aërial and of submarine navigation, both being carried out by floating in a medium which entirely surrounds the vessel.

Bibliography. ———

Index to the Periodicals of 1895 (Pp. viii. and 232); Ditto of 1896 (Pp. viii. and 226). London: *Review of Reviews'* Office, 1896–1897. Size 10 × 8.

Bibliography.

Geographical Index (Extra-European) to Books, Periodicals, etc., 1896. Map Room, Intelligence Division, War Office, December 31, 1896. Size 11 × 7½, pp. xx. and 98. *Presented by the Intelligence Division, War Office.*

Bibliography. *Natural Science* **10** (1897): 395–405. **Arçtowski.**

The Genealogy of the Sciences as the Basis of their Bibliography. By Henryk Arçtowski.

A clever exposition of the difficulties in the way of a classified bibliography of scientific literature, and a suggestion as to a possible solution, the practicability of which is not, however, demonstrated.

Bibliography.

General Index to the First Fifty Volumes of the *Quarterly Journal* of the Geological Society. Compiled and edited by the Assistant-Secretary. Part ii. La—Z. London: Longmans & Co., 1897. Size 9 × 6. *Presented by the Geological Society.*

Bibliography—Oriental. **Müller—Scherman.**

Orientalische Bibliographie begründet von August Müller . . . bearbeitet und herausgegeben von Dr. Lucian Scherman. X. Jahrgang. Erstes Halbjahrsheft. Berlin: Reuther & Reichard, 1897. Size 9½ × 6, pp. 146.

British Colonies. *Fortnightly Rev.* **61** (1897): 862–870. **Salmon.**

The Colonial Empire of 1837. By E. Salmon.

A gloomy view of the condition of British colonies sixty years ago.

British Empire. *Scottish G. Mag.* **13** (1897): 308–315. **Kirkpatrick and Prothero.**

The Unity of the Empire. (Abstract of Lectures delivered before the Society by Prof. J. Kirkpatrick, M.A., LL.D., and Prof. G. W. Prothero, M.A., D. Litt., in January and March, 1897.)

Challenger Expedition.

Challenger Expedition Reports. Portraits of the Contributors, reproduced from the photographs presented by them to John Murray, Naturalist on the *Challenger* Expedition and Editor of the "Challenger" Reports; with Facsimiles of the designs for the cover and dedication of the Album containing them, by Walter Crane. London: Dulau & Co., 1897. Size 12½ × 10½. 19 *Plates of Portraits.*

This interesting volume is a reduced facsimile of a presentation-album given to Dr. Murray, of the *Challenger*, by the contributors to the 'Reports' of that expedition, and it contains the portraits of them all. Being uniform in size with the official 'Reports,' it forms a concluding volume which no library possessing that work would willingly be without.

Classification of Science. **Arçtowski.**

La Généalogie des Sciences. Quelques remarques sur la Bibliographie des Mémoires scientifiques et le Principe de la Classification naturelle des Sciences. Par Henryk Arçtowski. [Extrait du *Bulletin de l'Institut international de Bibliographie* (2me Année, 1897, fascicule 3).] Bruxelles: F. Larcier, 1897. Size 10 × 6½, pp. 20. *Presented by the Author.*

An appeal for the consideration of the historical development of a science in constructing a scheme of classification.

Commercial Geography. **Flux.**

Mem. and P. Manchester Lit. & Philos. S. **41** (1897): No. 11, pp. 1–18.

The Costs of Sea Transport in proportion to Values of Cargoes. By A. W. Flux, M.A. *With Plates.*

We regret to notice that the Manchester Literary and Philosophical Society has adopted the method of separately paging the memoirs published by them, thus changing a volume of easy reference into a bundle of pamphlets.

Commercial Geography. **Hegemann.**

Mittlere Entfernungen auf Dampferwegen in Seemeilen. Im Auftrage der Direktion der Seewarte berechnet von Kapt. F. Hegemann. Beiheft I. zu den "Annalen der Hydrographie und Maritimen Meteorologie," Heft IV. (April), 1897. Berlin: E. Siegfried Mittler u. Sohn. Size 11 × 7½, pp. 22.

Alphabetical table of distances between important seaports in nautical miles.

Commercial Geography. *G.Z.* **3** (1897): 28–35, 92–104, 153–160. **Oppel.**

Uebersichten der Wirtschaftsgeographie. Von A. Oppel.

A careful summary of the economic geography of all the continents, with reference to the producing regions and the markets of the world.

Commercial Geography—Gold. *Ann. G.* 6 (1897): 193-211. **Foville.**

La géographie de l'or. Par M. A. de Foville. *With Map.*

The map of the world illustrating this article has printed over each great gold-producing region a yellow rectangle proportional in size to the actual annual production of the precious metal. The gold-producing countries stand in the ratios—United States, 241·5; South Africa, 240; Australia, 231; Russia, 150; the figures representing millions of francs.

Constellation-figures. *J.R. Asiatic S.* (1897): 205-226. **Brown.**

On the Origin of the Ancient Northern Constellation-figures. By Robert Brown, jun.

Cosmographic Speculation. **Robertson.**

Is the Earth a Planet? A Study in Physical and Mathematical Geography. By C. Robertson, M.D. Edinburgh: St. Giles' Printing Co., 1897. Size 9½ × 6, pp. viii. and 82. *Price 2s. Presented by the Publishers.*

Dr. Robertson states in his preface that his earlier statements that the sun is no larger than it appears to be, and that the Earth is not a planet, have not been contradicted. If a person untrained in anatomy were to assert that the blood does not circulate in the human body, and that the arteries are filled with air, it is improbable that any medical or biological journal would take the trouble to attempt to convince him. The cases seem to us to be strictly analogous.

Educational. **Marinelli.**

Se e come l'Università italiana possa provvedere al fine di preparare insegnanti di Geografia per le scuole secondarie. Relazione del Prof. Giovanni Marinelli.—Atti del II° Congresso Geografico Italiano, Roma 1895. Roma, 1896. Pp. 377-387.

Educational. **Ricchieri.**

Prof. Giuseppe Ricchieri. Gli studi geografici nello sviluppo della civittà e nell' educazione moderna. Prolusione letta il 25 marzo 1897, alla R. Università di Palermo. Firenze, 1897. Size 9½ × 6½, pp. 22. *Presented by the Author.*

Prof. Ricchieri's inaugural address in the Chair of Geography at the University of Palermo. He touches on the educational position of geography in the different countries of Europe.

Educational. **Siragusa.**

Dei limiti e dello scopo dell' insegnamento della Geografia nelle Facoltà di lettere e filosofia. Relazione del Prof. Giovanni Battista Siragusa.—Atti del II° Congresso Geografico Italiano, Roma, 1895. Roma, 1896. Pp. 388-396.

Educational. *J. Manchester G.S.* 12, 1896 (1897): 183-187. **Reed.**

Practical Geography in Manchester. By J. Howard Reed.

A paper read by Mr. Reed at the meeting of the British Association in Liverpool in 1896.

Educational. **Spencer.**

Chapters on the Aims and Practice of Teaching. Edited by Frederic Spencer, M.A., &c. Cambridge: the University Press, 1897. Size 8 × 5½, pp. viii. and 284. *Price 6s. Presented by the Cambridge University Press.*

This handbook, especially the chapter on the teaching of geography, by Mr. Yule Oldham, has already been referred to (*ante*, p. 220).

Educational. *J. School G.* 1 (1897): 81-85. **Davis.**

The Use of Geographical Periodicals. By W. M. Davis.

Prof. Davis gives a capital illustration of the way in which teachers may gain the fullest educational profit from geographical papers. He takes as an example Mr. Clifford's paper on the Malay States in the January number of the *Geographical Journal*, and shows not only how to extract the essential and characteristic facts, but how best to keep a record of such facts available for ready reference.

Educational—Methods. **Pasanisi.**

Il Metodo Ciclico nell' insegnamento secondario della Geografia. Relazione del Prof. Francesco Maria Pasanisi.—Atti del II° Congresso Geografico Italiano, Roma, 1895. Roma, 1896. Pp. 411-419.

Educational—Methods. *Rev. G. Italiana* 4 (1897): 204-212. **Bigoni.**

La geografia nelle scuole classiche, del Prof. Guido Bigoni.

On the teaching of geography in classical schools, with many references to Italian literature on the subject.

Educational—Plant-distribution. *J. School G.* **1** (1897): 97–102. **MacMillan.**
Geographical Distribution of Plants. By Conway MacMillan.

Frontier Delimitation. *P.R. Artillery I.* **24** (1897): 207–230. **Trotter.**
The Science of Frontier Delimitation. By Lieut.-Colonel J. K. Trotter, R.A.
A note on this paper will be given.

Geography. **Wisotzki.**
Zeitartömungen in der Geographie. Von Dr. Emil Wisotzki. Leipzig: Duncker & Humblot, 1897. Size 10 × 7, pp. x. and 468. *Price* 10*s.*
A series of monographs showing extensive reading and dealing from the historical point of view with special questions in geography. The titles of the separate essays are—On Springs, The Aim of Geography, The Mutual Relations of Mountain Systems, On Pure Geography, An Appreciation of Ritter, Ritter on Vertical Relief, The Term Continent, The Eastern Boundary of Europe, The Divisions of Asia.

NEW MAPS.

By J. COLES, *Map Curator*, R.G.S.

EUROPE.

Balkin Peninsula. **Baldacci.**
Botanische Original-Karte von Mittelalbanien u. Epirus. Bearbeitet von Dr. A. Baldacci. Scale 1 : 1,000,000 or 15·7 stat. miles to an inch. *Petermanns Geographische Mitteilungen*, Jahrgang 1897, Tafel 12. Justus Perthes, Gotha, 1897. *Presented by the Publisher.*

Caucasus. **Schuchardt.**
Das Kharthwelische Sprachgebiet im Südweslichen Kaukasus von Prof. Dr. Hugo Schuchardt. Scale 1 : 1,300,000 or 21·2 stat. miles to an inch. *Petermanns Geographische Mitteilungen*, Jahrgang 1897, Tafel 6. Justus Perthes, Gotha, 1897. *Presented by the Publisher.*

England and Wales. **Ordnance Survey.**
Publications issued since July 8, 1897.

6-inch—County Maps (revised):—
ENGLAND AND WALES:—**Hampshire**, 19 N.E, 30 S.E., 31 N.E., 33 S.E., 34 N.E., 40 N.W., S.W. 1*s.* each.

25-inch—Parish Maps, revised:—
ENGLAND AND WALES:—**Durham**, V. 3; VII. 2, 5; VIII. 15; XXVIII. 14; XXXIII. 12, 13, 14, 15; XXXIV. 7, 9, 11; XXXV. 3, 4, 6, 7, 8, 9, 11, 12; XXXVI. 7, 9, 10, 11, 12, 16; XXXVII. 5, 6, 13, 14; XL. 7. **Essex**, XIII. 3, 7, 8, 11, 12, 15, 16; XIV. 5, 6, 7, 10, 11, 12, 13, 14, 15, 16; XV. 1, 2, 5, 6, 8, 9, 10, 11, 12, 13, 14, 15, 16; XVI. 6, 14, 16; XVII. 13; XXII. 3; XXIII. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10; XXIV. 1, 2, 3, 7, 13; XXV. 1, 2, 3, 4, 5, 6, 7, 8, 12, 14; XXVI. 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 14, 15, 16; XXXI. 12; XXXV. 8, 16; XXXVI. 1, 5, 6, 10, 13, 14, 15; XLI. 6; XLV. 1, 3, 4, 7; XLVI. 1, 2, 3, 6, 9, 10, 11, 16; LII. 4, 8; LV. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 15, 16; LVI. 1, 5, 13; LXIII. 8, 11, 12, 13. 14, 15, 16; LXIV. 1, 2, 5, 6, 9, 13; LXX. 8; LXXI. 2, 4, 7, 8, 9, 10, 11, 13, 14; LXXII. 1, 2, 6, 9, 13; LXXVI. 6; LXXVII. 16; LXXVIII. 5, 6, 9, 10, 13; LXXIX. 1, 4, 7, 9, 10; LXXXIII. 5, 12; LXXXV. 2, 3, 4. **Hampshire**, XXI. 13; XXXVI. 8; XLIV. 12, 14, 15, 16; LIII. 1, 9; LIV. 12; LXII. 15, 16; LXIII. 16; LXIV. 11, 12, 13; LXV. 3, 5; LXVI. 13; LXX. 1, 2, 3, 5, 8; LXXI. 1; LXXII. 2, 3, 11; LXXIV. 7, 16. **Kent**, X. 16; XI. 3, 4, 6, 7, 9; XII. 9; XXXI. 9, 10, 13; XXXII. 2, 3, 5, 6, 7, 8, 12, 13, 14, 15, 16; XLII. 9; XLIII. 2, 3, 7, 8, 12, 13; LIII. 2; LX. 11. **Middlesex**, XVII. 4, 12, 15; XVIII. 13; XXII 2; XXV. 8. **Northumberland**, XXXVII. 15, 16; XLII. 13, 14, 15; XLIII. 4, 6, 8, 10, 11, 12, 14, 15, 16; XLIV. 3, 5, 8, 10, 11, 12, 13, 14, 15, 16; XLIX. 5, 9, 10; LI. 2, 3, 4, 6, 7, 8, 11, 12, 15; LII. 1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 14. 15, 16; LIII. 1, 2, 3, 4, 5, 6, 7, 8, 10, 14; LIV. 2, 4, 5, 6, 7, 8; LV. 1, 5, 6, 7, 8; LVI. 13; LVIII. 2, 6, 7, 8, 11, 12, 15; LIX. 3, 4, 15; LX. 1, 3, 4, 5, 9; LXI. 1, 2, 3, 4; XCVI. 2, 5, 13, 14; XCVII. 1, 5. **Surrey**, IV. 14; XI. 10, 12, 13, 14, 15, 16; XIII. 8, 16; XIV. 1, 2, 3, 4, 5, 6, 7, 9, 10, 11; XXI. 1, 2,

12, 15; XXII. 4, 5, 6, 7, 8, 9, 10, 11, 12; XXIII. 4, 7; XXIV. 1, 2, 3, 5, 6, 10, 11. **Sussex,** IV. 14; XI. 10, 12, 13, 14, 15, 16; XIII. 8, 16; XIV. 1, 2, 3, 4, 5, 6, 7, 9, 10, 11; XXI. 1, 2, 12, 15; XXII. 4, 5, 6, 7, 8, 9, 10, 11, 12. 3*s.* each.

London, 142–148, 151, 152. This is now *complete* in 160 sheets. 3*s.* each. (*E. Stanford, Agent.*)

Germany. **Halbfass.**

Tiefenkarte der Eifelmaare. Nach eigenen Lotungen entworfen von Dr. Wilhelm Halbfass. Scale 1 : 25,000 or 2·5 inches to a stat. mile. *Petermanns Geographische Mitteilungen*, Jahrgang, 1897, Tafel 11. Gotha: Justus Perthes. *Presented by the Publisher.*

Germany. **Lepsius.**

Geologische Karte des Deutschen Reichs auf Grund der unter Dr. C. Vogels Redaktion in Justus Perthes Geograph. Anstalt ausgeführten Karte in 27 Blättern in 1 : 500,000 (or 7·8 stat. miles to an inch). Bearbeitet von Dr. Richard Lepsius. Lieferung xiii. Blatt 9 u. 10. Lieferung xiv. Blatt 8, and Index. Justus Perthes, Gotha. *Price 3 marks each part.*

The present issues complete this excellent map, and are accompanied by a full index, which adds considerably to its value for purposes of reference.

AFRICA.

Central Africa. **Beringer.**

A map of the Shire Highlands (British Central Africa Protectorate). By O. L. Beringer, A.M.I.C.E. Scale 1 : 126,720 or 2 stat. miles to an inch. 2 sheets. 1897. Edward Stanford, London. *Presented by the Author.*

In this map the hills are shown by contour-lines, the heights of the principal elevations being given in feet, all roads and tracks are laid down, and the positions of military posts, police stations, etc., are indicated. As the map is drawn on a large scale, it will be found useful for reference by all persons having an interest in the British Central Africa Protectorate.

German East Africa. **Kiepert and Moisel.**

Karte von Deutsch-Ostafrika. Scale 1 : 300,000 or 4·7 stat. miles to an inch. Sheet D iv. Kilimatinde. Berlin: Geographische Verlagshandlung Dietrich Reimer (Ernst Vohsen).

This sheet includes the country lying between latitudes 5° 30′ S. and 7° S., and from long. 34° E. to 36°. The routes followed by Cameron, Burton and Speke, Stanley, Emin Pasha, Pearson, Burdo, Prince, and other explorers, are laid down. The latest reliable material has been employed in the compilation of this map, which is a valuable addition to the sheets already published.

AMERICA.

Central America. **Sapper.**

Verteilung des Regenfalls im Nördlichen Mittelamerika: Regenfall in der Verapaz in den Monaten Januar u. Juli. Entworfen von Dr. Carl Sapper. Scale 1 : 1,000,000 or 15·7 stat. miles to an inch. *Petermanns Geographische Mitteilungen*, Jahrgang 1897, Tafel 10. Gotha: Justus Perthes. *Presented by the Publisher.*

Bolivia. **Sanjines.**

Mapa Postal de Bolivia. Scale 1 : 3,400,000 or 53·5 stat. miles to an inch. Victor E. Sanjines el Director General de Correos, La Paz, 1896. *Presented by the Direccion General de Correos, La Paz.*

AUSTRALASIA.

New Guinea. **Lauterbach and Kersting.**

Vorläufige Skizze des Reiseweges der Kaiser Wilhelm Land Expedition im Jahr. 1896. Entworfen von Dr. Lauterbach und Dr. Kersting. Scale 1 : 3,000,000 or 47·9 stat. miles to an inch. Gesellschaft für Erdkunde zu Berlin. Sitzung vom 2 Januar 1897. *Presented by the Berlin Geographical Society.*

GENERAL.

The Moon. **Weinek.**

Photographic Atlas of the Moon. Based chiefly on focal negatives of the Lick Observatory, to the scale of 10 feet to the Moon's diameter, executed by Prof. Ladislas Weinek, PH.D., SC.D. Maginus sheet. Published by Carl Bellmann in Prague. *Presented by the Publisher.*

CHARTS.

United States Charts. **U.S. Hydrographic Office.**

Monthly Current Chart for the North Pacific Ocean for July, 1897. Published at the Hydrographic Office, Washington, D.C. *Presented by the U.S. Hydrographic Office.*

PHOTOGRAPHS.

Africa. **Schweinfurth.**

Photographs of the Italian possessions on the Red Sea coast of Africa (Eritrea), taken by Dr. G. Schweinfurth in 1894. *Presented by Dr. G. Schweinfurth.*

This series contains 40 photographs, which have been well chosen to illustrate the nature of the scenery and natives of the Italian possessions on the coast of the Red Sea. They form a valuable addition to the Society's collection.

(1) Group in front of a house at Adi Soga (Mai Mafeles); (2) Camp at Saganeiti; (3) Group in front of a house at Adi Soga (Dembelas); (4) Children sitting round an Abyssinian table in Adi Soga (Mai Mafeles); (5) Shoan horse (the property of S. Guascon, of Massaua; (6) Travelling silversmith of Adi Soga; (7) Glen with pool at Halai; (8) Ditto; (9) *Euphorbia tirucalli* trees near church at Mai Mafeles; (10) Market scene at Halai, with native soldiers; (11) Valley of the Anseba with sycamore trees; (12) Camp below Adi Soga, Adi Golgol on the left; (13) Glen with pools near Halai (east side); (14) Halibaret, view towards the south-east—an *Adansonia* in the foreground; (15) Dr. M. Schoeller and his hunters in Kohaito; (16) Mohamed Okud and Lebal Idris, our guides (Beni Amer, Salendoa); (17) Three Saho, Assaorta, with Omar Ahmed of Kohaito in the centre; (18) Mahio, Glen of the Haddas; (19) Church at Saganeiti; (20) Beni Amer, three of our camel-drivers; (21) Beni Amer huntsmen; (22) Near Halibaret, view towards south, Kirba Halib peak on the right; (23) Road-making near Ambelaco; (24) Camp near Ambelaco; (25) Eshka glen, Kohaita from the north-west; (26) Glen of Gua, near Saganeiti, with *Ficus palmata*; (27) Grove of *Euphorbia Abyssinica* near the church of Amba Sareb, in the neighbourhood of Godofelassi; (28) *Cassia Arereh* near Mai Mafeles, Dembelas; (29) *Gardenia lutea* near Mai Mafeles; (30) *Aloe shimperi* near Saganeti; (31) Large rosebush near Halai (*Rosa Abyssinica*); (32) Mansurah valley; (33) Safira, Old Dyke (eastern half), Kohaito; (34) Glen with pool, *Ficus capensis* on the right; (35) Chor Mansurah, Upper Barka (Wadi); (36) Glen with pool at Halai, with *Ficus capensis*; (37) *Boswellia papyrifera* near Mai Mafeles, Dembelas; (38) Zad Amba from the south-west, near well on the Shetel river; (39) Large juniper tree near Halai; (40) No title.

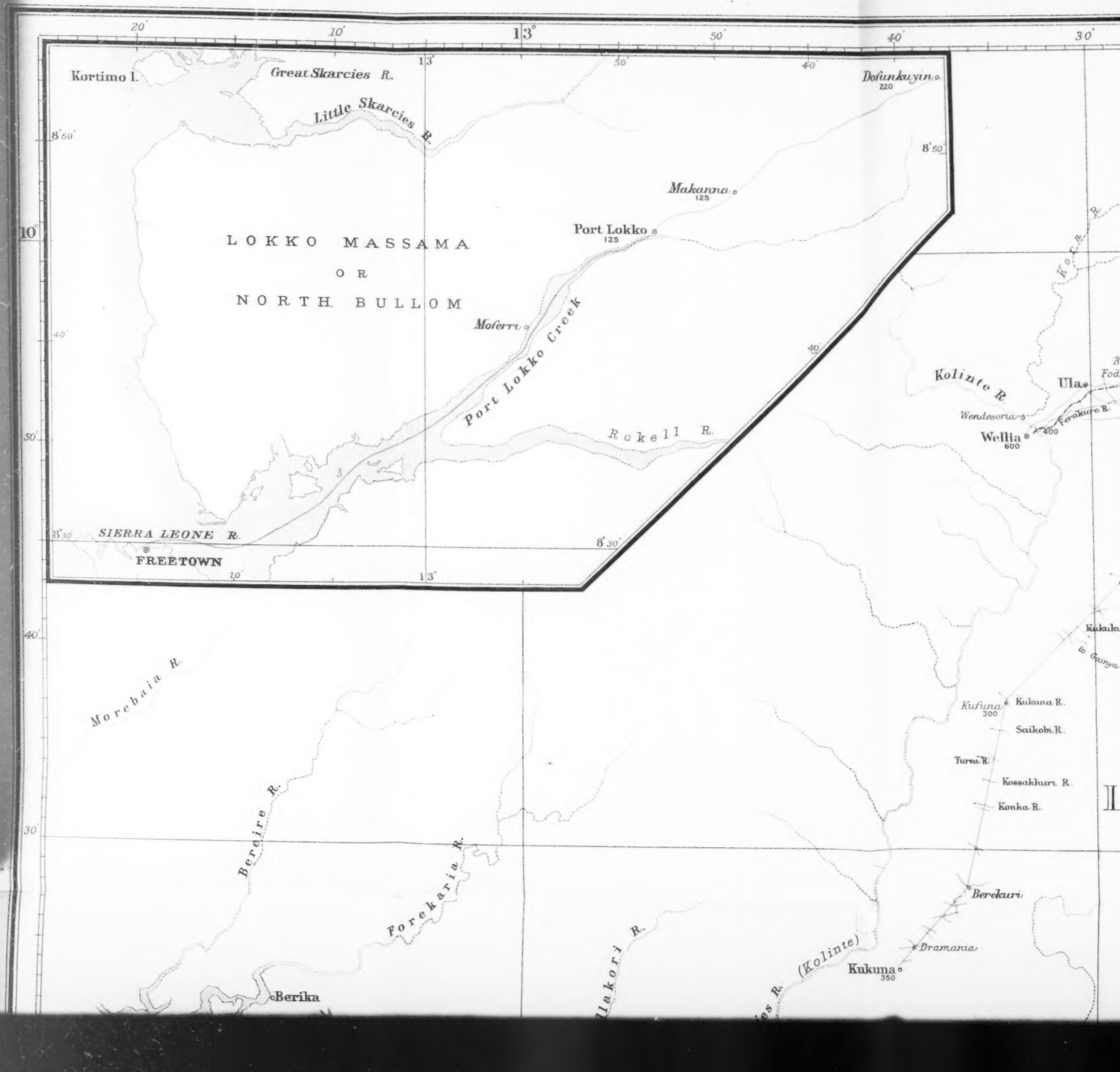
Vancouver Island. **Laing.**

Twenty-one Photographs of Vancouver Island, taken by J. W. Laing, Esq., M.A. *Presented by J. W. Laing, Esq., M.A.*

The beautiful scenery of the interior of Vancouver island is shown in these photographs, which, though taken under difficulties, are remarkably good specimens of what a traveller may do in this direction.

(1) Our camp, Tahsis valley; (2) Kowse glacier and mountain, 5000 feet, head of Woss lake; (3) Head of Ilupana Aram; (4) The rapids, Nimpkeesh river; (5) McQuinna, chief of Nootha, great grandson of the McQuinna who met George Vancouver; (6) Trout 4½ lbs., caught at head of great central lake; (7) A catch of trout before breakfast; (8) Devil's Club plantation, Tahsis valley; (9) Near the mouth of the Tahsis river; (10) Left-hand river flowing into head of great central lake; (11) Tahsis mount, 5600 feet, and Tahsis river; (12) Our camp on the Kla-Anch river; (13) Nimpkeesh lake; (14) Log jamb on Kla-Anch river; (15) Right-hand river, head of Great Central Lake; (16) Kla-Anch river; (17) Group of Muchalat Arm Indians; (18) Head of Great Central Lake; (19) The rapids of Kla-Anch river; (20) Woss lake (looking up); (21) Connuma peak, 4890 feet.

N.B.—It would greatly add to the value of the collection of Photographs which has been established in the Map Room, if all the Fellows of the Society who have taken photographs during their travels, would forward copies of them to the Map Curator, by whom they will be acknowledged. Should the donor have purchased the photographs, it will be useful for reference if the name of the photographer and his address are given.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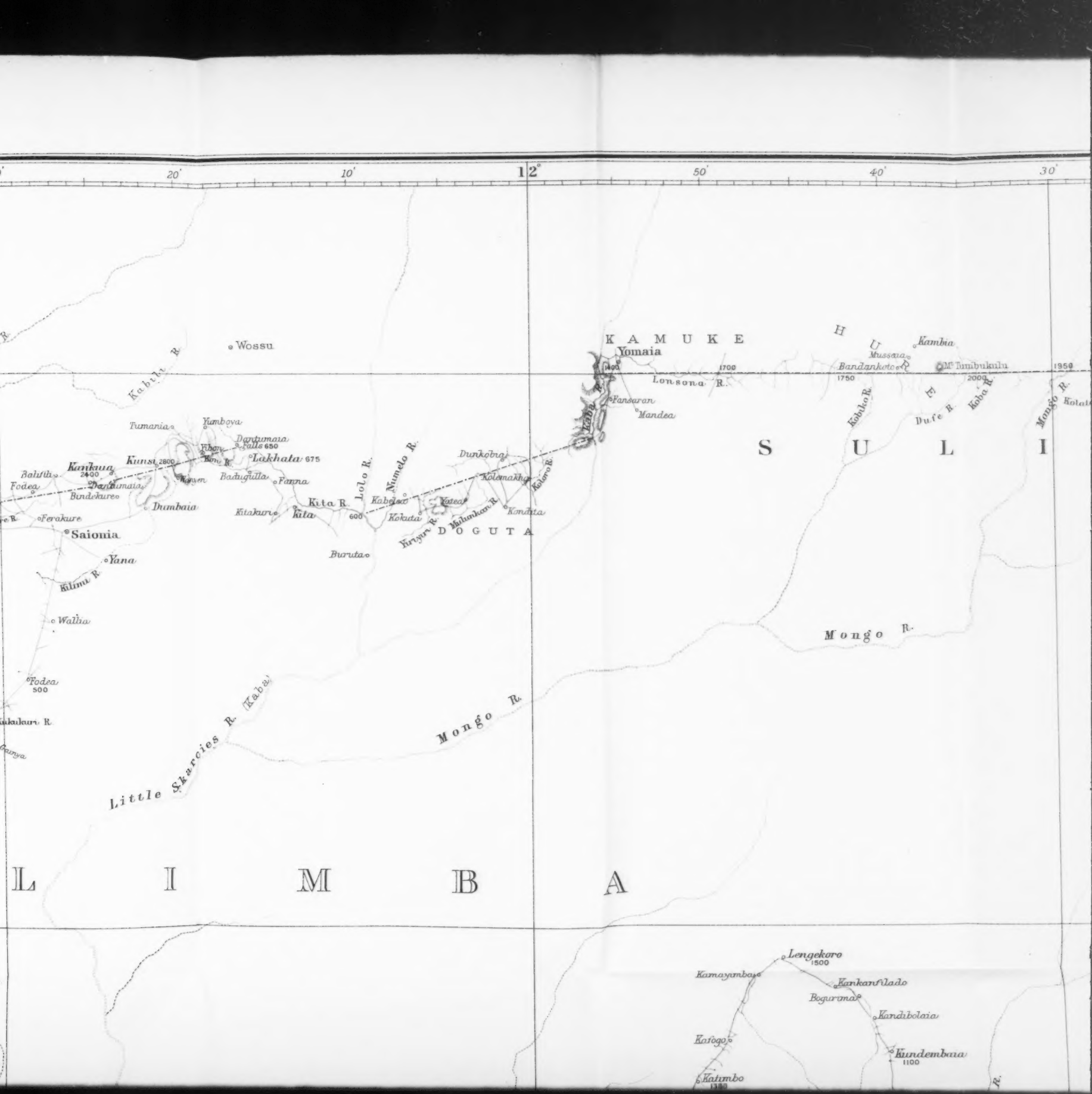
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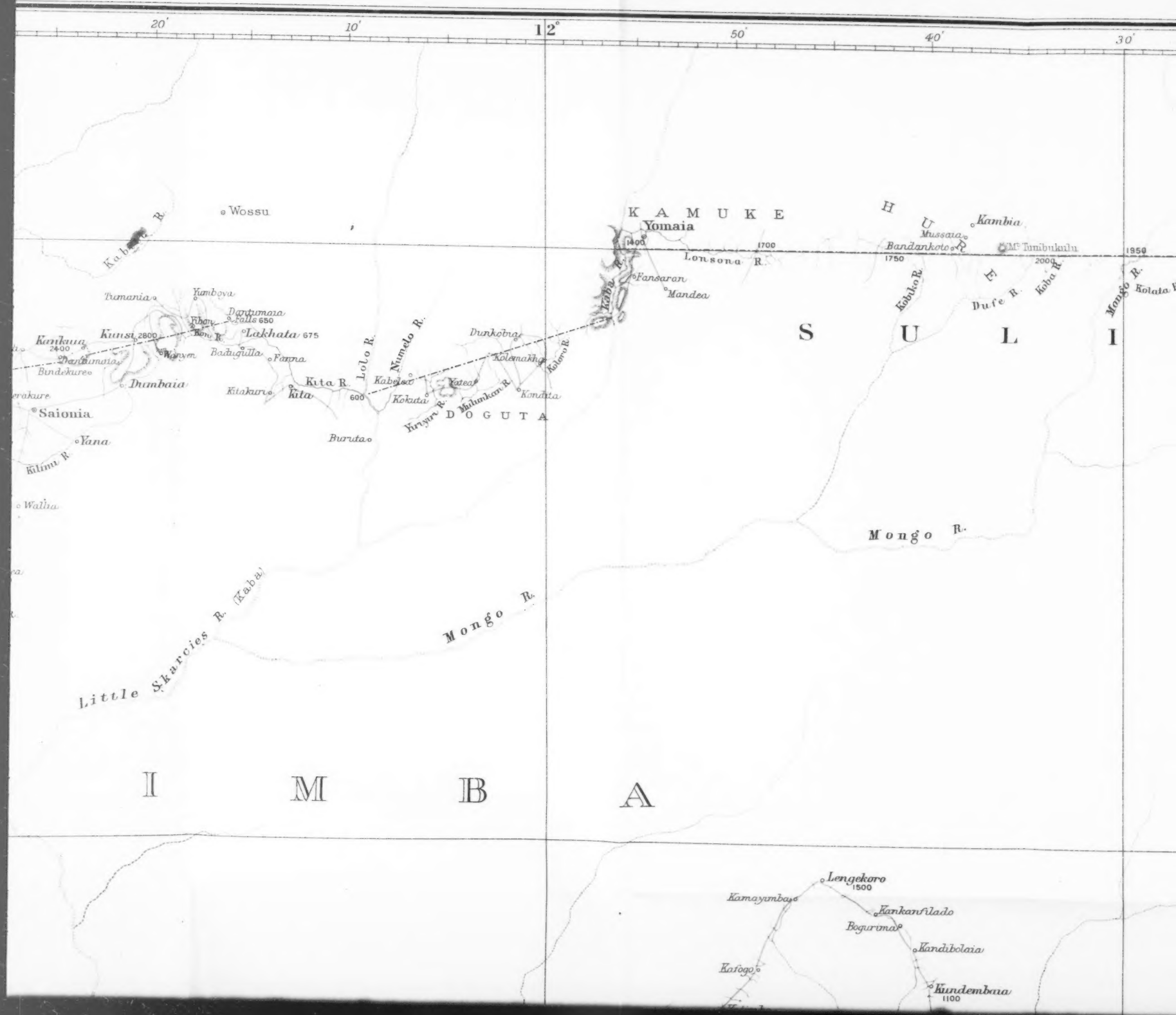
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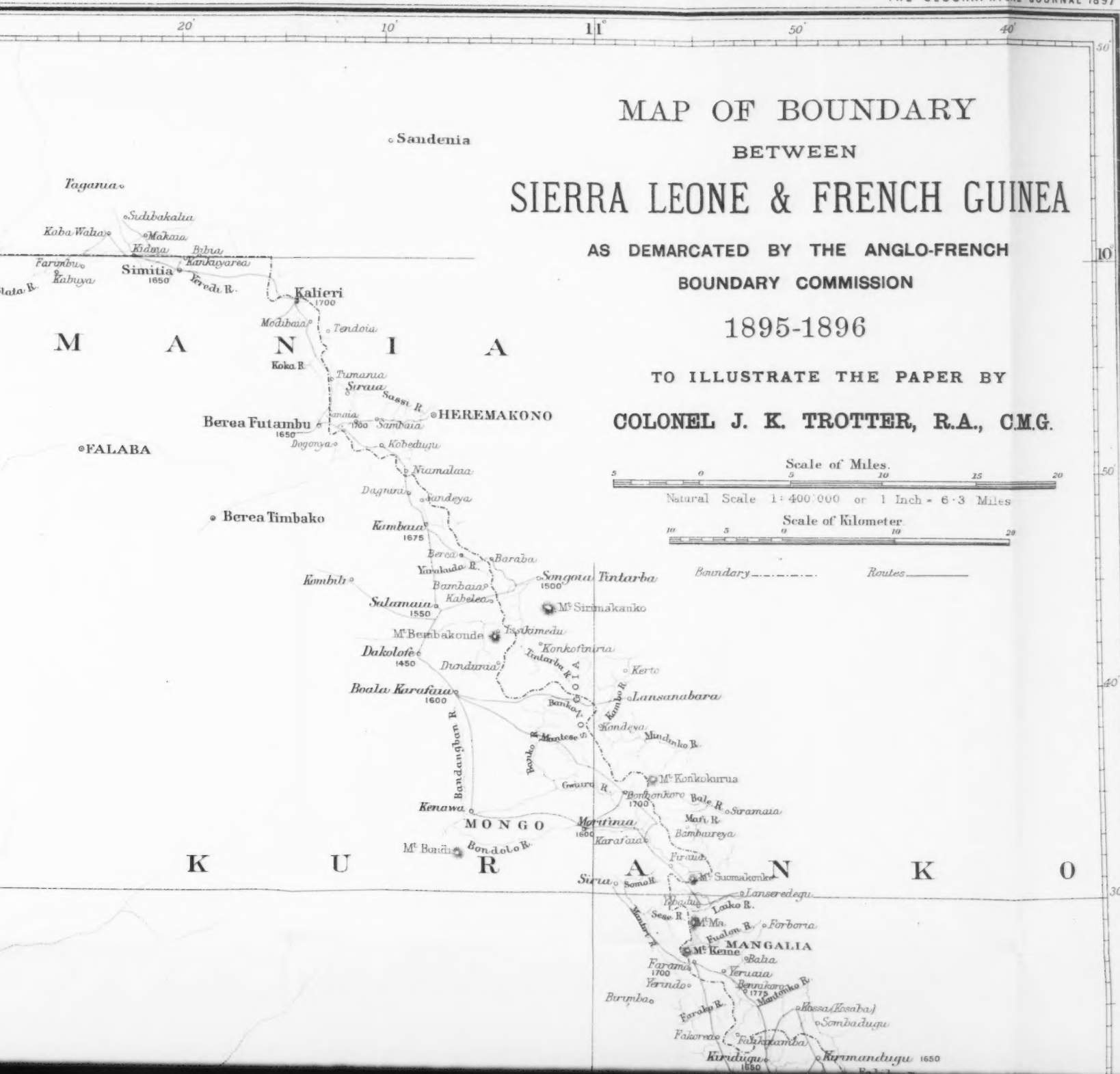
MAP OF BOUNDARY
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AS DEMARCATED BY THE ANGLO-FRENCH
BOUNDARY COMMISSION
1895-1896
TO ILLUSTRATE THE PAPER BY
COLONEL J. K. TROTTER, R.A., C.M.G.
Scale of Miles.
Natural Scale 1:400,000 or 1 Inch = 6·3 Miles
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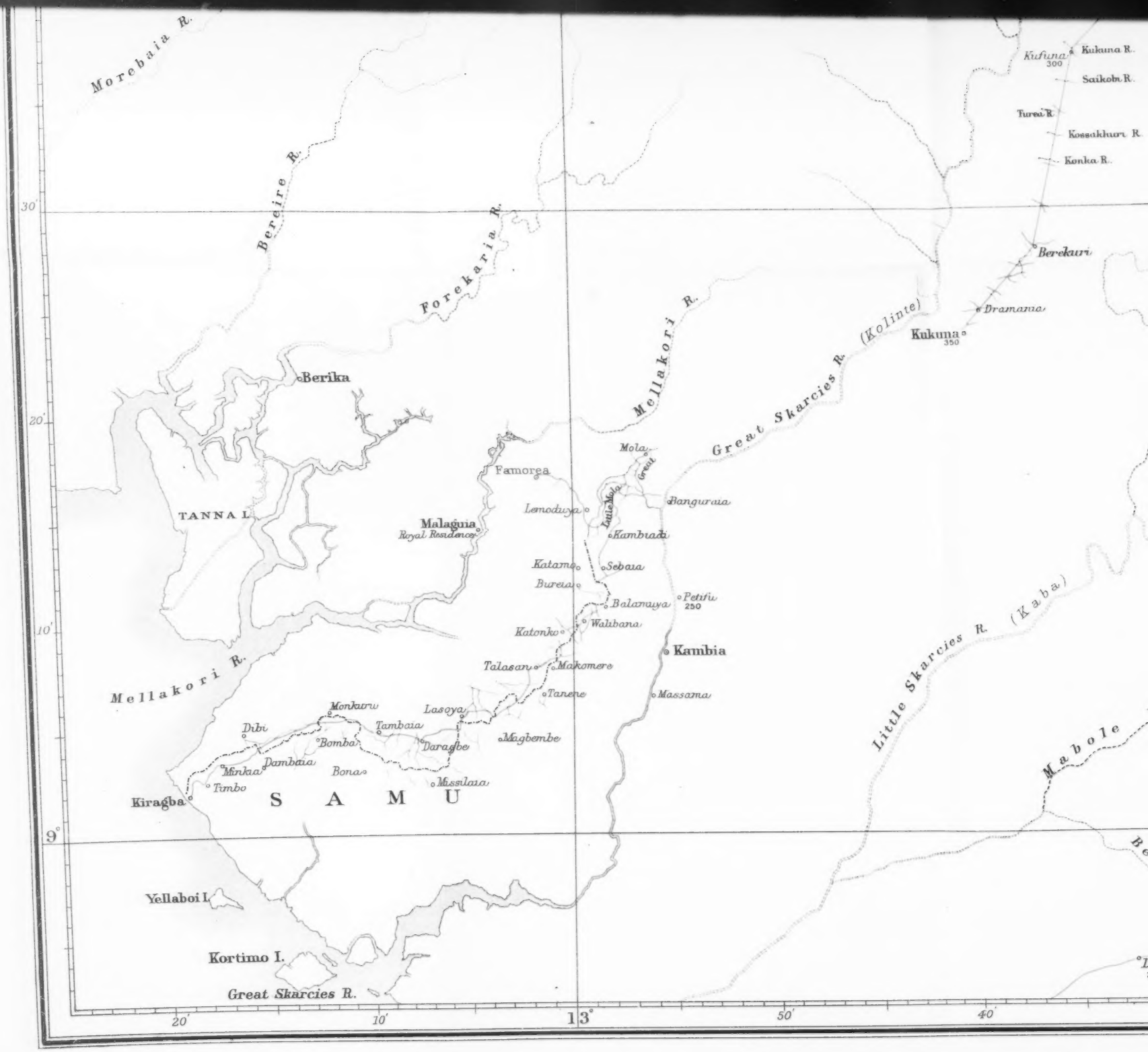
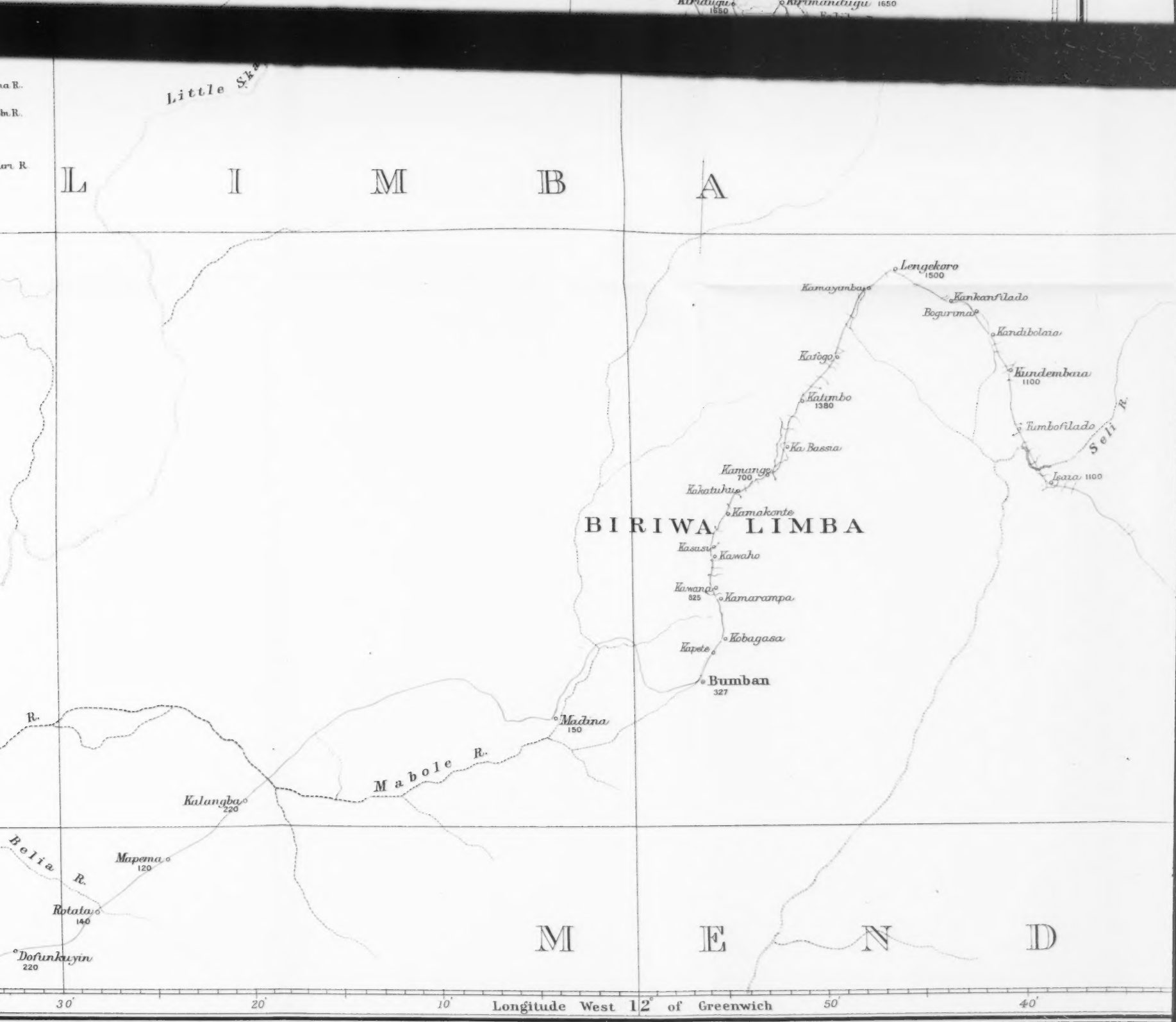
Yeredu R.
Kalieri
1700
Modibaia
Tendoia
M A N I A
Koka R.
Tumania
Siraia
Sassi R.
HEREMAKONO
Berea Futambu
1650
Sambaia
Dogonya
Kobeduqu
FALABA
Niamalaia
Dagnira
Sandeya
Berea Timbako
Kambaia
1675
Berea
Baraba
Yarakuda R.
Kombih
Bambaia
Songoia Tintarba
1500
Salamaia
1550
Kabelea
Mt Sirimakanko
Mt Bembakonde
Yesikimedu
Konkofiniria
Dakolofe
1450
Dundiraia
Tintarba R.
Kerto
Boala Karafaia
1600
Bankoro
Kambo R.
Lansanabara
Kondeya
Mandinko R.
Bandanghan R.
Banko R.
Mantese
Mt Konkokurua
Gwaira R.
Bonkonkoro
1700
Bale R.
Siramaia
Kenawa
MONGO
Mafi R.
Marutinua
1600
Karafaia
Bambureya
Mt Bondo
Bondolo R.
Firaia
K U R A N K O
Siria
Soma R.
Mt Suomakonko
Lanseredegu
Yabadu
Laiko R.
Sese R.
Mt Ma
Forboria
Fualon R.
Mt Keine
MANGALIA
Baha
Farama
1700
Yeruaia
Yerindo
Bennikoro
1775
Mantonko R.
Barimba
Farabo R.
Kassa (Kasaba)
Sambadugu
Fakoreaia
Fabakamba
Kuriduqu
1650
Kurmanduqu
1650


Morebaia R.
Bereire R.
Forekaria R.
Mellakori R.
Great Skarcies R. (Kolinte)
Little Skarcies R. (Kaba)
Mabole
Kufuna
300
Kukuna R.
Saikobi R.
Turea R.
Kossakhuri R.
Konka R.
Berekuri
Dramania
Kukuna
350
Berika
TANNA L.
Malaguia
Royal Residence
Famorea
Mola
Great
Little Mola
Lenoduya
Banguraia
Kambiada
Katame
Sebaia
Bureia
Balamaiya
Petifu
250
Walibana
Katonko
Kambia
Talasan
Makomere
Tanene
Massama
Monkaiw
Lasoya
Dibi
Tambaia
Bomba
Daragbe
Magbembe
Dambaia
Minkaa
Bona
Timbo
Missulaia
Kiragba
S A M U
Yellaboi I.
Kortimo I.
Great Skarcies R.
30'
20'
10'
9°
20'
10'
13°
50'
40'



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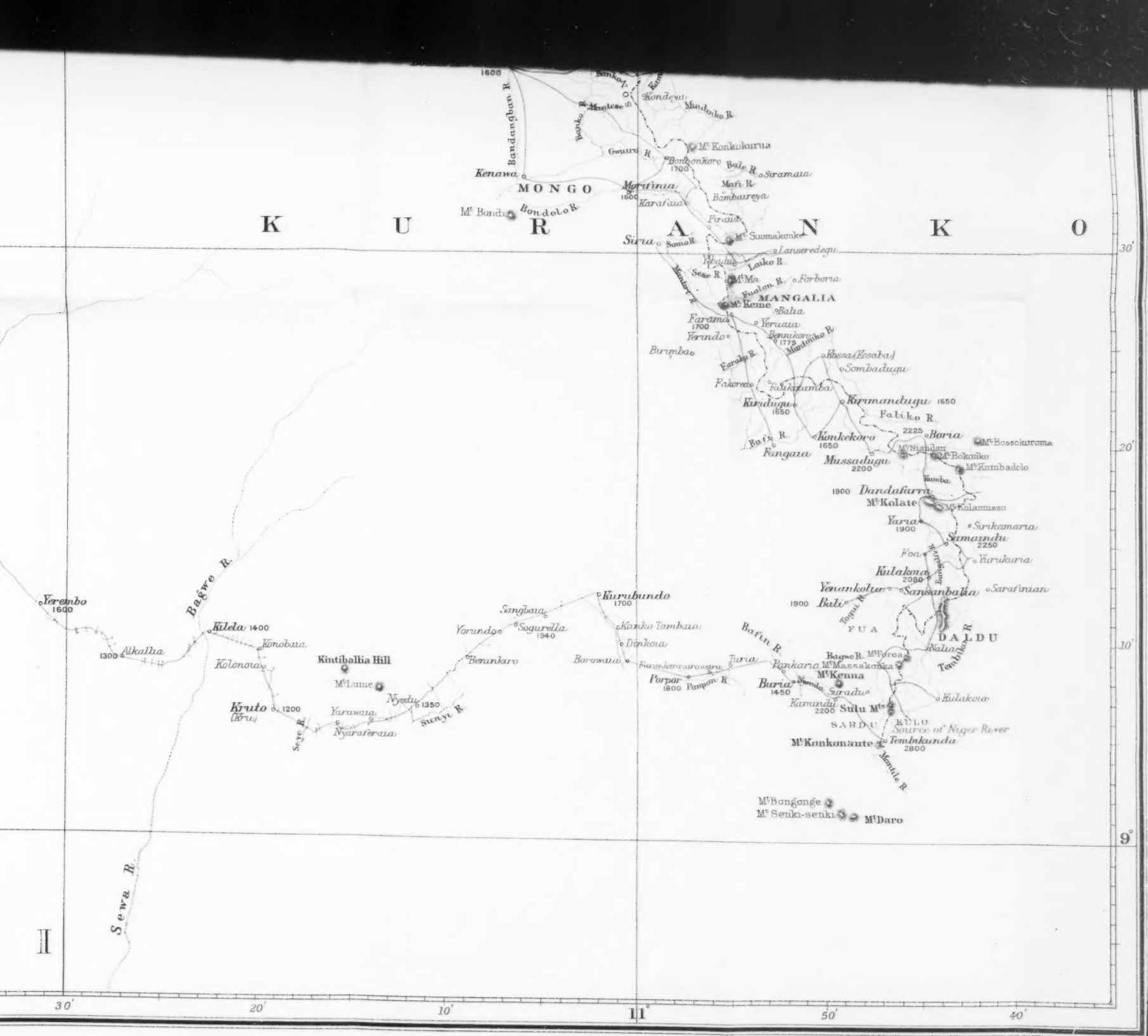
KURANKO
MONGO
MANGALIA
FUA
DALDU
SARDU
KULO
Source of Niger River
Bagwe R.
Sewa R.
Bandangban R.
Bondolo R.
Mandeko R.
Bafin R.
Togui R.
Sunyi R.
Seye R.
Pampan R.
Kenawa
Morifina
1600
Siria
Somal R.
Sese R.
Lanseredegu
Laiko R.
Forboria
Baliá
Yeruaia
Faramá
1700
Yerundo
Burimba
Bennikoro
1775
Bossa (Kosaba)
Sombadugu
Fakoreá
Fakaramba
Kirudugu
1650
Karmandugu
1650
Faliko R.
Konkekoro
1650
Boria
2225
Bafix R.
Fangaia
Mussadugu
2200
Dandafarra
1900
Mt Kolate
Yaria
1900
Samandu
2250
Kulakora
2080
Yenankoluo
Sansanbalia
1900
Bali
Kurubundo
1700
Sangbaia
Yorundo
Sogurella
1940
Kanko Tambaia
Dinkoia
Berunkoro
Borowaia
Yerembo
1600
Alkalia
1300
Kilela
1400
Konobaia
Kolonoua
Kintiballia Hill
Mt Lume
Kruto
1200
(Kru)
Nyedu
1350
Yarawaia
Nyaraferaia
Porpar
1800
Buria
1450
Karandal
2200
Sulu Mts
Mt Konkonaute
Tembikunda
2800
Mt Bongonge
Mt Senki-senki
Mt Daro
Mt Konkokurua
Bale R.
Mafi R.
Karafaia
Bambureya
Furaia
Mt Suumakenke
Mt Ma
Mt Kenne
Mt Bossokuroma
Mt Nianian
Mt Bokonko
Mt Kumbadelo
Mt Kolamuso
Surikamaria
Yurukuria
Saraf'nian
Mt Fefrea
Mt Massakonza
Mt Kenna
Kulakoia
Nalia
Tembikun R.
Bagwe R.
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Kondeya
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Gwuru R.
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Mt Lume
Kruto
1200
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Nyedu
1350
Yarawaia
Nyaraferaia

I
Sketch Map of the
Districts round the
SOUTHERN PORTION
OF
LAKE NYASA.

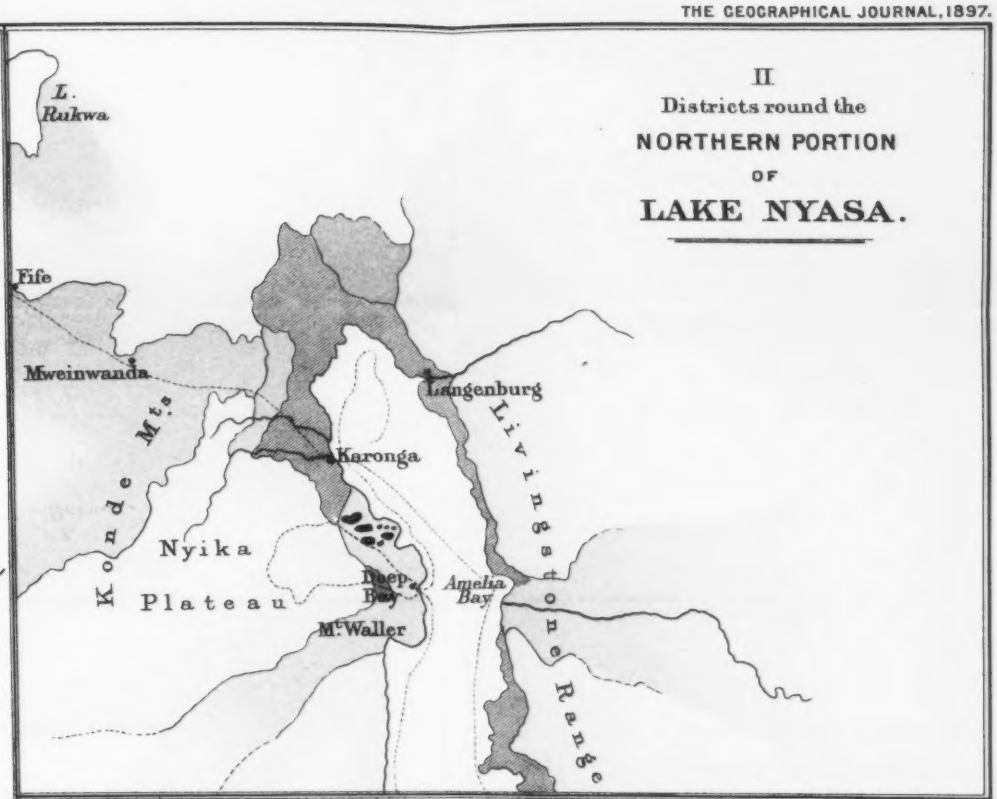
II

Districts round the

NORTHERN PORTION

OF

LAKE NYASA.



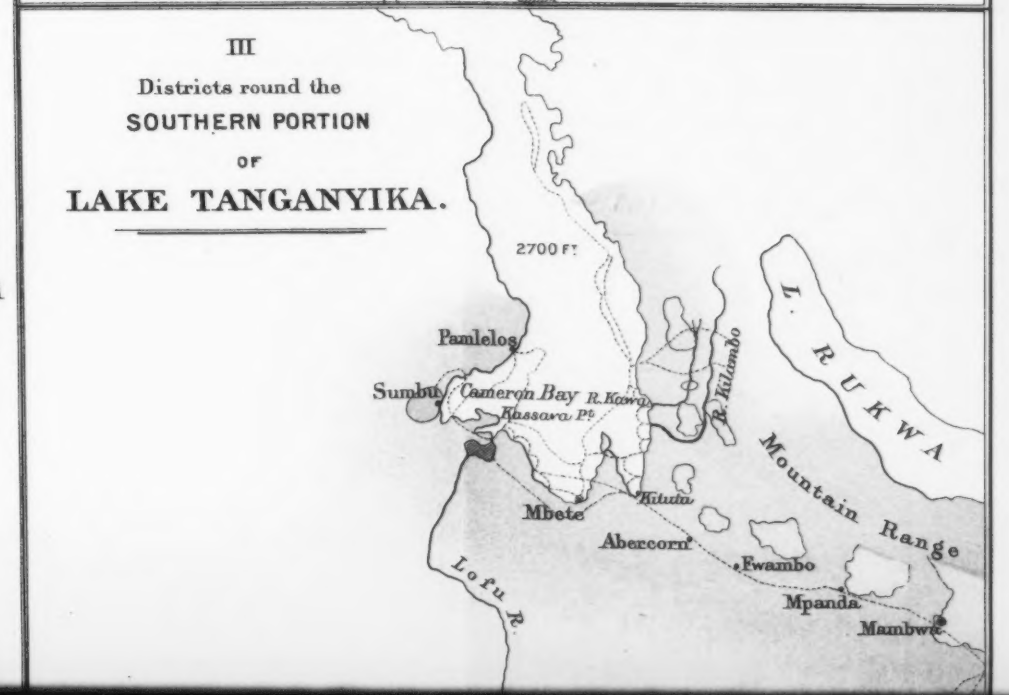
III

Districts round the

SOUTHERN PORTION

OF

LAKE TANGANYIKA.



I

Sketch Map of the Districts round the

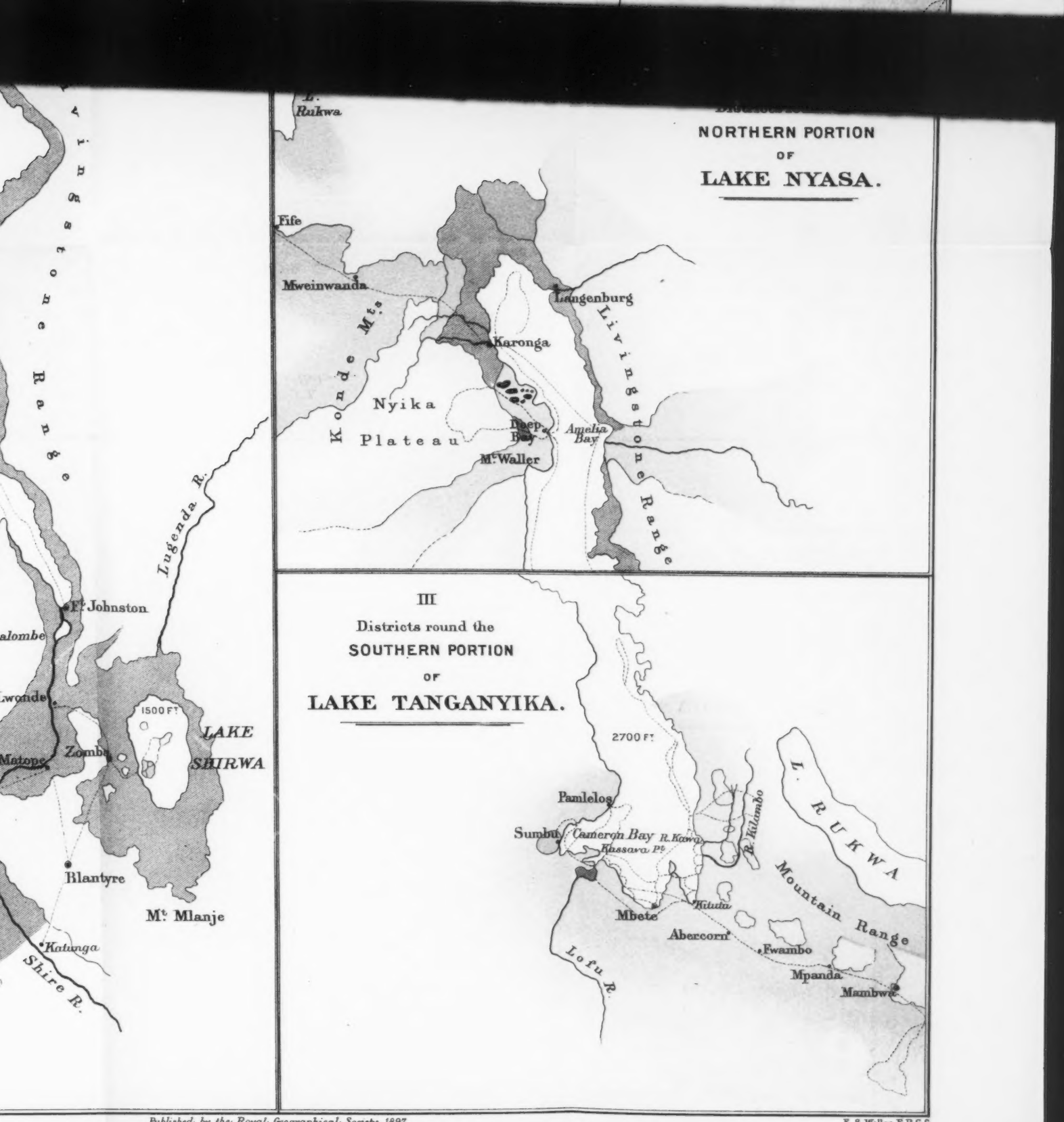
SOUTHERN PORTION OF

LAKE NYASA.

Showing the Distribution of the Geological Formations by

J.E.S. Moore, A.R.C.S.

Granitoid Rocks, Gneiss &c.



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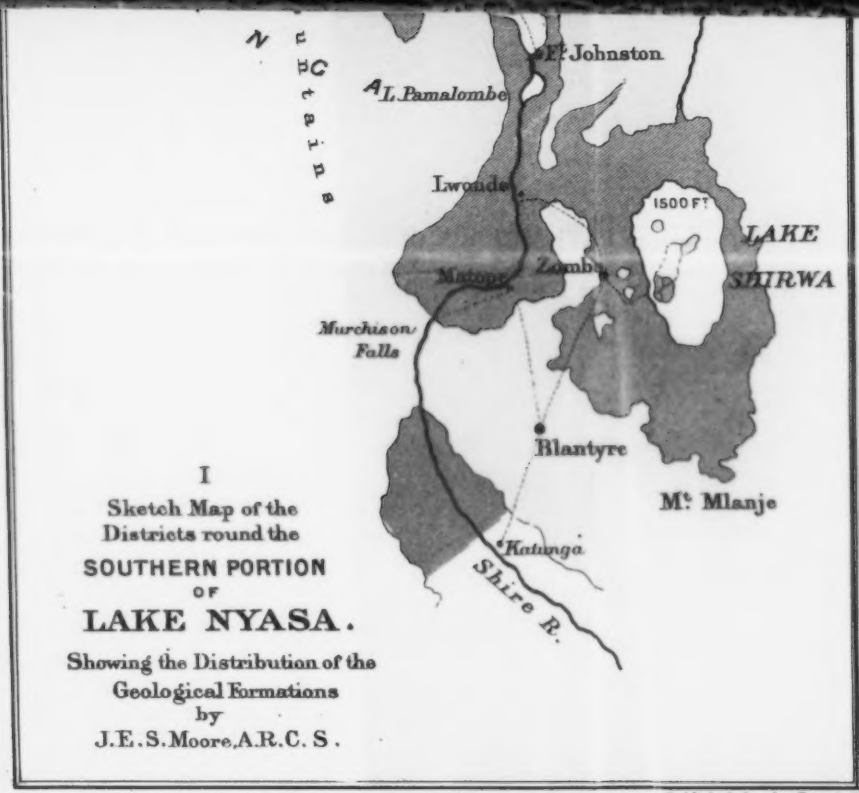
F. S. Weller, F.R.G.S.

Sandstone of the great interior plateau. Triassic Formations. Volcanic. Modern Calne Limestone.

Alluvium of the lake shores.



I

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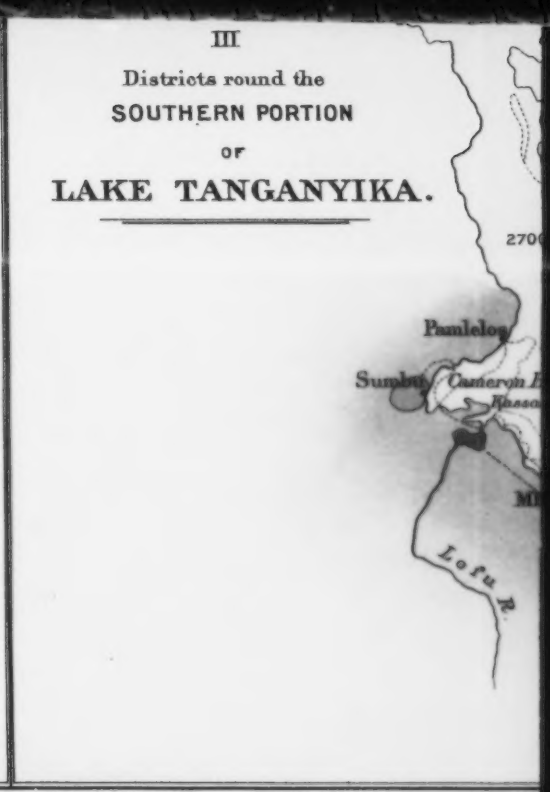

III

Districts round the
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Granitoid Rocks, Gneiss &c. | *Sandstone of the great interior plateau.* | *Triassic Formations.* | *Volcanic.*

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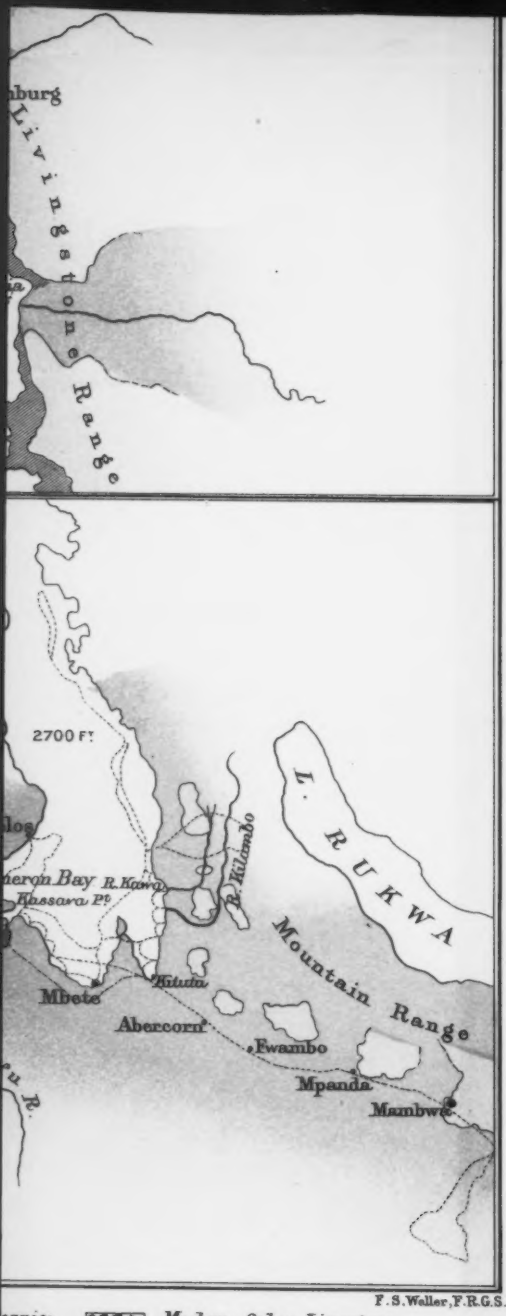

F. S. Weller, F.R.G.S.

canic. Modern Coline Limestone.